

AD-A071 058

ORI INC SILVER SPRING MD

F/G 13/10

STUDY OF TASK PERFORMANCE PROBLEMS IN REPORTS OF COLLISIONS, RAM--ETC(U)

MAR 79 B PARAMORE, V KEITH, P KING

DOT-CG-41903-A

UNCLASSIFIED

ORI-TR-1474

USCG -D-28-79

NL

AD
A071058



OF

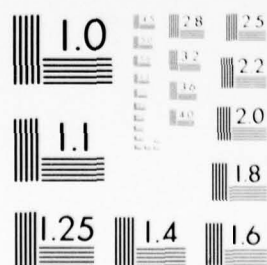
4



1 OF 4

AD

A071058



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

Report No. CG-D-28-79

LEVEL

B
B.S.

AD A 071 058

STUDY OF TASK PERFORMANCE PROBLEMS IN
REPORTS OF COLLISIONS, RAMMINGS, AND GROUNDINGS
IN HARBORS AND ENTRANCES



MARCH 1979

FINAL REPORT

Document is available to the public through the
National Technical Information Service,
Springfield, Virginia 22151

DDC FILE COPY

Prepared for

U.S. DEPARTMENT OF TRANSPORTATION
United States Coast Guard
Office of Research and Development
Washington, D.C. 20590

79 07 11 003

NOTICE

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no liability for its contents or use thereof.

The contents of this report do not necessarily reflect the official view or policy of the Coast Guard; and they do not constitute a standard, specification, or regulation.

This report, or portions thereof may not be used for advertising or sales promotion purposes. Citation of trade names and manufacturers does not constitute endorsement or approval of such products.

(14) ORI-TR-1474

Technical Report Documentation Page

1. Report No. D-28-79	2. Government Accession No. (18) USCG	3. Recipient's Catalog No.
4. Title and Subtitle (6) Study of Task Performance Problems in Reports of Collisions, Rammings, and Groundings in Harbors and Entrances	5. Report Date (11) March 1979	6. Performing Organization Code
7. Author(s) (10) B. Paramore, V. Keith, P. King, J. Porricelli, R. Willis	8. Performing Organization Report No. ORI Technical Report No. 1474	9. Performing Organization Code
9. Performing Organization Name and Address ORI, Inc. 1400 Spring Street Silver Spring, Maryland 20910	10. Work Unit No. (TRAIS)	11. Contract Number (15) DOT-CG-41903-A Task Order V
12. Sponsoring Agency Name and Address U.S. Coast Guard Office of Research and Development Washington, D.C. 20590	13. Type of Report and Period Covered (9) Final Report	14. Sponsoring Agency Code G-DSA-1/TP44
15. Supplementary Notes The U. S. Coast Guard project leader and project monitor were, respectively, Dr. John S. Gardenier and CDR James C. CARD.		
16. Abstract (12) 385 p. <p>This is a study of vessel accidents in harbors and harbor entrance areas. It addresses accidents involving at least one ship of more than 10,000 gross registered tons or a tug or towboat-barge array. The study period is FY 1972-76. The first objective was to identify patterns in accident causal factors, especially the coincidence of characteristics of the maneuvering situation and problems in task performance by the vessel controller. An additional objective was to evaluate the potential of proposed solutions to vessel control problems.</p> <p>The study involved controlled data-taking from the archive of accident reports maintained by the U.S. Coast Guard. A multivariate analysis design was employed to allow combinations of factors to be explored, since vessel accidents rarely can be attributed to a single cause.</p> <p>The study identified several prominent task performance problem areas associated with environmental forces and maneuvering constraints. Differences were indicated between the human factors in collisions and those evident in rammings and groundings.</p>		
17. Key Words accident analysis (marine); accident factors (marine); barge accidents; bridge personnel performance; collisions, rammings and groundings; harbor accidents; human factors; marine safety; ship accidents; vessel control	18. Distribution Statement Document is available to the U. S. public through the National Technical Information Service, Springfield, VA 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 22. Price

393 988 Gau

Accession For	
NTIS GTRM	<input checked="checked" type="checkbox"/>
DDC TAB	<input type="checkbox"/>
Unannounced	<input type="checkbox"/>
Justification	
By	
Distribution/	
Availability Codes	
Dist	Available and/or special
A	

TABLE OF CONTENTS

	<u>Page</u>
LIST OF ILLUSTRATIONS	iii
I. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS	1-1
DESCRIPTION OF THE STUDY	1-1
MAJOR FINDINGS	1-7
CONCLUSIONS AND RECOMMENDATIONS	1-17
ORGANIZATION OF THE REPORT	1-30
II. DESCRIPTION OF THE STUDY	2-1
BACKGROUND	2-2
STUDY OBJECTIVES	2-4
METHODS	2-5
III. DESCRIPTION OF THE ACCIDENTS	3-1
PRESENTATION FORMAT	3-2
VESSEL DESCRIPTION	3-3
ENVIRONMENTAL CONDITIONS	3-27
PERSONNEL INFORMATION	3-36
OTHER QUESTIONS	3-41
TASK PERFORMANCE FACTORS	3-49
CASUALTY CONSEQUENCES	3-87

TABLE OF CONTENTS (cont'd)

		<u>Page</u>
IV.	ANALYSIS OF ACCIDENT FACTOR RELATIONSHIPS.	4-1
	LIMITATIONS OF THE ANALYSIS	4-2
	PROCEDURES.	4-3
	ANALYSIS OF COLLISION PRECIPITATING FACTORS	4-4
	COMMUNICATION PROBLEMS.	4-7
	COMPARISON WITH FINDINGS IN OTHER STUDIES	4-14
	OTHER TASK PROBLEMS ASSOCIATED WITH COMMUNICATION PROBLEMS.	4-15
	ENVIRONMENTAL FACTORS AND COMMUNICATIONS PROBLEMS	4-16
	ANALYSIS OF GROUNDING PRECIPITATING FACTORS	4-32
	ANALYSIS OF RAMMING PRECIPITATING FACTORS	4-37
	COMMENTS ON THE CONTINGENCY ANALYSIS	4-40

LIST OF ILLUSTRATIONS

Figure		Page
1.1	Distribution of Collisions, Rammings, and Groundings: Comparison of Sample to Population	1-5
2.1	Distribution of Collisions, Rammings, and Groundings: Comparison of Sample to Population	2-8
2.2	Ship and Barge Involvement in Groundings and Rammings: Comparison of Sample to Population	2-9
2.3	Ship and Barge Involvement in Collisions: Comparison of Sample to Population	2-10
2.4	Relative Proportions of Cargo Types for Ships and Barges: Comparison of Sample to Population	2-11
Chart		
3.1-3.11	Vessel Description/Ships	3-6
3.12-3.19	Vessel Description/Barges	3-19
3.20-3.25	Environmental Conditions	3-30
3.26-3.27	Personnel Information	3-39
3.28-3.32	Other Questions	3-44
3.33-3.34	Casualty Precipitating Factors/Exceptional Circumstances . . .	3-51
3.35-3.41	Casualty Precipitating Factors/Vessel Control Task	3-59
3.42A	Casualty Precipitating Factors/Communication/Radio	3-66
3.42B	Casualty Precipitating Factors/Communication/Signaling	3-69
3.43-3.44	Casualty Precipitating Factors/Environmental	3-73

3.45-3.47	Casualty Precipitating Factors/Environmental/Visual	3-77
3.48-3.51	Casualty Precipitating Factors/Environmental/Other	3-83
3.52-3.53	Casualty Consequences	3-88

Table

2.1	Overview of Harbor Casualty Analysis Gauge Content	2-13
3.1	Incidence of Task Performance Factors in Accidents of Each Type	3-54
4.1	Rank Order of Task Performance Problems in Collisions	4-5
4.2	Rank Order of Task Performance Problems in Collisions, Controlling for Late Detection	4-6
4.3	Failures to Attempt Voice Communication	4-8
4.4	Associations Between Communications Failures on the Two Vessels in Collision	4-11
4.5	Attempts at Communication When Detection Occurred	4-13
4.6	Factors Associated with Failure to Maintain Position as a Collision-Precipitating Factor	4-19
4.7	Factors Associated with Late Detection	4-21
4.8	Complexity of the Maneuvering Situation In Relation to Excessive Speed	4-24
4.9	Factors Associated with Inappropriate Speed When Visibility is Taken Into Account	4-25
4.10	Other Task Factors Associated with Failure to Monitor the Position and Movement of the Other Vessel	4-29
4.11	Task Performance and Situational Factors in Groundings	4-33
4.12	Two-Way Associations Between Task and Situational Factors in Groundings	4-34
4.13	Three-Way Associations of Precipitating Factors in Groundings	4-36
4.14	Task Performance Factors and Situational Factors in Ramming	4-38
4.15	Associations Between Task and Situational Factors in Ramming	4-39

I. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

"We believe that the hope of eliminating a large number of accidents by a single, generally applicable safety initiative is illusory. The system is dynamic and complex, and it must be considered as a whole. It seems inevitable that various adjustments will be needed, in several aspects of the system, to increase performance reliability.

"Finally, accident prevention in a living system must be recognized to be a continuing process. So must identification of safety problems. As the system changes, the problems and appropriate solutions change" (pages 1-29 - 1-30).

DESCRIPTION OF THE STUDY

This is a study of collisions, ramming, and groundings of commercial vessels in U.S. harbors and harbor entrance areas. Accident reports were analyzed to identify task problems and situational factors that combined to bring about the accidents. The study focused on clarifying the specific nature of human performance problems leading to accidents and on clarifying the circumstances that contribute to human performance problems since the large majority of collisions, ramming, and groundings have been attributed in previous research to human error.

The first objective was to see whether major precipitating factors, or clusters of factors, might be identified, to make the job of developing and applying accident preventive measures more manageable. A second objective was to evaluate preventive measures that have been proposed in light of the study findings about major precipitating factors. (See page 2-4 of the main body of the report for more detailed statement of study objectives.)

The study was performed for the U.S. Coast Guard, Office of Research and Development, under Contract DOT-CG-41903-A, Task Order V.

Background (See pages 2-2 through 2-4 of the main body of the report.)

Task analyses were previously performed under this contract to specify the human performance requirements of vessel control on oceangoing ships and on towboats on the inland waterways system.¹ The task analyses were sought by the Coast Guard to establish a baseline from which to clarify human factors in vessel operating safety.

Previous studies have identified human error as the largest category of problems leading to accidents.² Difficulty arises, however, in breaking out the elements of this broad problem area. Mental errors and errors of omission are involved more often than overt action errors. In addition, several errors generally can be identified in a case, the effects of which depend on other variables such as available channel width, proximity of another vessel or some other obstacle, and vessel response characteristics. The relationships between the environment, the hardware, and human operator behavior have not been clarified sufficiently to make it possible to understand how situational factors may promote human error or may allow an error to escalate into an accident. The nature and complexity of the problems have made it extremely difficult to define cost-effective regulatory solutions.

The task analyses of vessel control provided a framework within which to analyze human operator performance in vessel accidents and a systematic terminology by which to categorize performance problems. The potential errors were defined in terms of necessary task results that were not accomplished satisfactorily. We could then look for trends in problem tasks and for associ-

¹ J. Smith et al., Task Analysis of Vessel Control, 3 vols., Silver Spring, Maryland: Operations Research, Inc., December 1976. U.S. Coast Guard Report No. CG-D-1-77. NTIS AD A037316.

² W. Dunn and P. Tullier, Spill Risk Analysis, Phase II: Methodology Development and Demonstration. Silver Spring, Maryland: Operations Research, Inc., November 1975. NTIS AD 785 026. Maritime Transportation Research Board, Human Error in Merchant Marine Safety. Washington, D.C.: National Academy of Sciences, June 1976. L. Stoehr et al., Spill Risk Analysis Program: Methodology Development and Demonstration, Volume I. Silver Spring, Maryland: Operations Research, Inc., May 1977. U.S. Coast Guard Report No. CG-D-21-77. NTIS AD A043054. H. Istance and T. Ivergard, "Ergonomics and Reliability in Ship Handling Systems - Theories, Models and Methods." Paper presented at the Fourth Ship Control Systems Symposium, Den Helder, The Netherlands, October 1975.

ation between task problems and aspects of the operating situations. The particular behaviors that may be documented in the case histories then can be seen as a more coherent body.

It should be noted that a distinction is made in this study between task-directed behavior and extraneous behavior that might interfere with effective task performance. The instances of the latter are shown to be comparatively very few in number.

It should also be noted that use of the term "human error" in this study does not imply that blame for an accident should be laid on the human operator. Even the most alert and skillfull operator lacks the means to guarantee control in some very common situations. It is neither fair nor productive to talk about human error as necessarily or even usually a matter of personnel deficiency. Rather, the focus is properly on the total situation and factors identifiable in the situation which strain reasonable performance capabilities and reduce the reliability of human performance in vessel control. The total system view is exceedingly important if much is to be done about human error in vessel control, and this topic is discussed in more detail in the conclusions at the end of this section.

Accident Population and the Study Sample (See pages 2-6 through 2-11.)

The accident population for this study includes all collisions, ramming, and groundings that occurred in harbor areas during the five-year period FY 1972 - FY 1976. An additional parameter is that the accident must have involved at least one ship of more than 10,000 gross registered tons (GRT) or a tug or towboat moving one or more barges.

Using the Coast Guard's Automated Vessel Casualty File, 1,343 involvements of vessels greater than 10,000 GRT were initially identified, plus 2,046 involvements of barges. These vessel involvements represent a total of 2,805 individual collisions, ramming, and groundings. Some of these were rejected because, when the reports were read, it was found that they did not fit within the population definition. Others were rejected because they did not provide enough information for detailed analysis. After screening, 419 reports were retained in the study sample, 15 percent of those identified through the Coast Guard information system.

Since the study sample was purposefully drawn rather than randomly drawn, it might not necessarily represent, on a given parameter, the population of all accidents within the study definition. However, it was necessary for the sample to be governed by availability of information.

Comparisons were made to evaluate the differences between the study sample and population. In general, they appear to be similar, as suggested in Figure 1.1, which shows the distribution of accident types in the initial population versus the final sample. The sample is discussed in more detail in Section II, and additional comparisons are provided which support the view that the study results are generally applicable to the collisions, rammings, and groundings addressed by the study definition.

Data Development (See pages 2-12 through 2-14.)

The study data base was created by analyzing the narrative information contained in the accident reports, which are compiled and maintained on microfilm by the Coast Guard. A comprehensive set of questions was written to ask of the reports, based on the previously cited task analyses and other studies. The questions were reviewed by vessel masters and pilots and additional questions were contributed by them. Responses to the questions were coded from the reports in a format suitable for quantitative analysis.

Two sets of questions were developed, one for rammings and groundings and one for collisions of separate, underway vessels. These sets of questions, called Casualty Analysis Gauges (CAGs), were used to survey the accident reports on a consistent basis (i.e., ask the same questions for all accidents of a given type and apply the same decisions rules in answering the questions). This was done to minimize the judgment bias introduced when individuals evaluate information without specific guidelines. A sample of each type of accident was coded by two or more individuals so that coding reliability could be measured. The overall agreement rate was approximately 90 percent. (See page 2-14.)

Each CAG included two major kinds of questions (plus case identification items):

- Questions were asked to determine the characteristics of the operational situation in which the accident occurred-- i.e.,

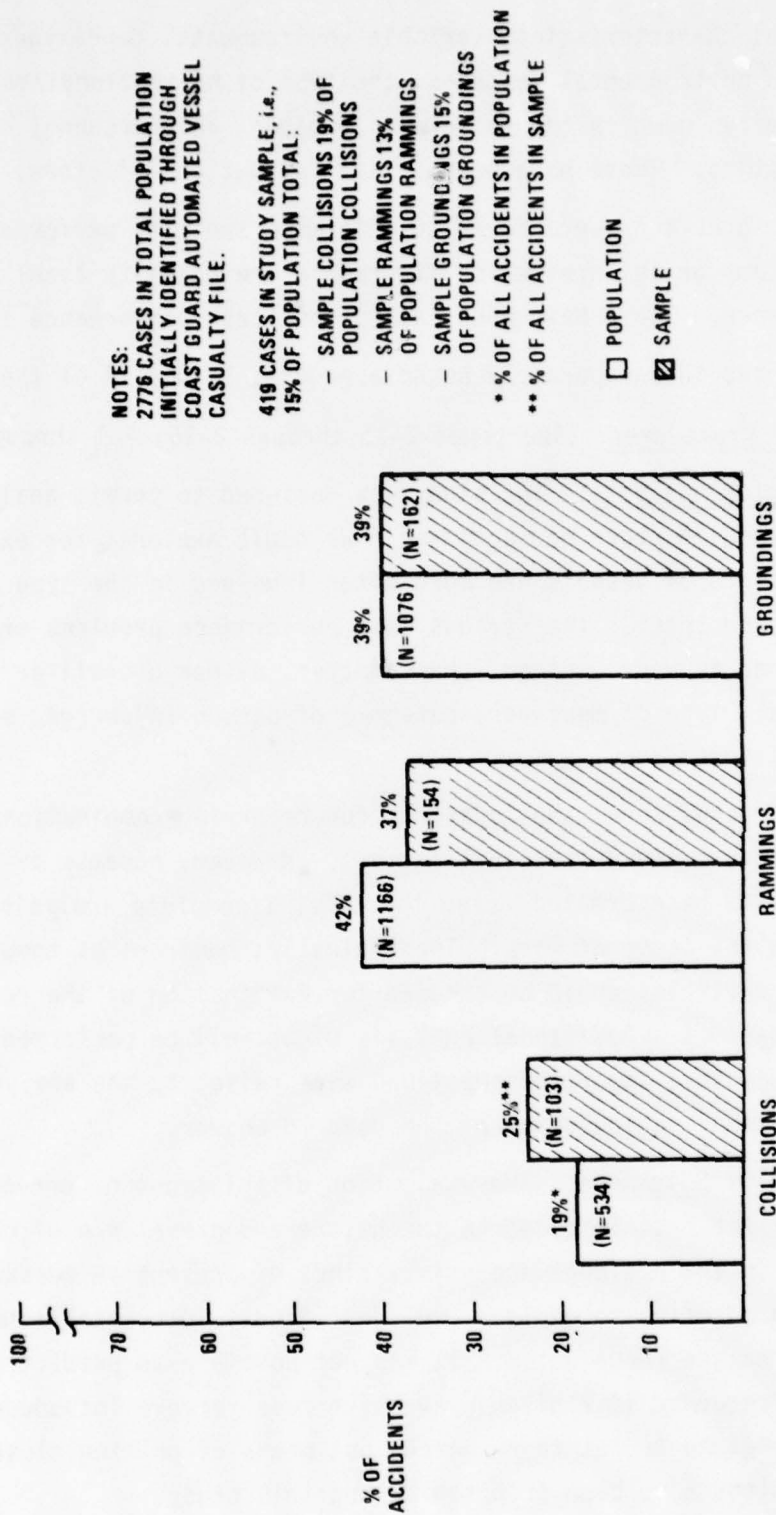


FIGURE 1.1. DISTRIBUTION OF COLLISIONS, RAMMINGS, AND GROUNDINGS:
COMPARISON OF SAMPLE TO POPULATION

vessel characteristics, variable environmental conditions, fixed environmental features, the type of navigational/maneuvering activity in which the vessel was engaged, and personnel characteristics. These have been called "situational factors."

- Other questions were asked to determine the task performance problems or failures which figured in the casualty event sequence. These have been called the "task performance factors."

The CAGs are presented in a separately bound appendix, Volume II of the report.

Analysis Design and Procedures (See pages 2-15 through 2-19, 4-1 through 4-4.)

Causal Factor Analysis. The study was designed to permit analysis of several possible causal factors per accident. We could explore, for example, whether different kinds of vessels are more often involved in one type of accident than another, and whether the various task performance problems are more often involved in one type of accident than another, either overall or for a given type of vessel, type of maneuver, category of person-in-charge, set of environmental conditions, etc.

Many comparisons were made to search for recurring combinations of task performance factors and situational factors. However, because of the large size of the data base created using the CAGs, a complete analysis could not be performed within the scope of work. Theoretically, hundreds of thousands of combinations of variables could be created for examination of the relationships of casualty factors. Additional analysis might well be performed on the data base. Moreover, some important questions were raised by the analysis which require additional manipulation of the data to answer.

Evaluation of Solutions. The evaluation of solutions or preventive measures is generalized. It is based on the nature and prevalence of causal factors identified in the accident analysis. Kinds of preventive measures which appear most productive to explore are identified. Some established and proposed measures are reevaluated. It was not possible to predict reductions in accident frequency if a given preventive measure were introduced. This task had to be given to future research, but means of getting closer to the desired predictions have been proposed during this study.

The study design is suitable for a type of preventive measure analysis which provides an indicator of "maximum expected effectiveness." This can be done by establishing criteria for when a given solution could possibly work to prevent an accident, and then determining the proportion of cases in which the criteria were met. Prototype analyses of this kind were done as part of the Spill Risk Analysis Program, previously cited.

However, such an analysis is most suited to evaluation of the impact of a preventive action in place-- that is, for estimating the impact on accident frequency or rate of an implemented safety initiative by studying accidents before and after implementation. (This was the case in the prototype analyses.) For developing a preventive measure and assessing its effects on pilotage before implementation, other forms of evaluation, preferably including real-time experimentation, appear to be needed in addition to historical data analysis. This is because the historical records are so likely not to include observations essential to the evaluation; the conditions under which the observations are taken cannot be fully controlled, and the results attributable to the preventive measure cannot be sufficiently isolated.

MAJOR FINDINGS

Overall, the human factors problems involved in the study sample of collisions were of a different character than those involved in the groundings and ramming. The latter two types of accidents were found typically to be cases of inability to maintain control, despite reasonable attention and diligence by the persons responsible for vessel control. Tasks were not omitted or wrongly performed in any obvious way. The typical ramming and grounding scenarios suggest classic human factors problems; it appears that aspects of the work situation are such that effective task performance cannot be counted upon.

The collisions, by contrast, were found to occur most often when essential tasks were omitted, often on both of the vessels involved. The most frequently omitted tasks were those which increase certainty about the intentions of the other vessel and about how to accomplish a safe passing.

At first glance, the task omissions involved in collisions may seem to be gratuitous-- to result from inattention or carelessness. However, a closer examination in light of other study data suggests that problems in training, equipment, regulations, and procedures may be fostering these omissions. It is also suggested that something about the interface between regular vessel personnel and pilots, especially on foreign-registered vessels, may be involved, as discussed and illustrated on pages 3-5 and 3-15, 3-16.

It will be noted that a sizable subset of the collisions seem to fall in between the larger trend for collisions and the more clearly control-related problems that predominate in the rammings and groundings. This is the subset in which failure to maintain navigational position was found to be a precipitating factor. This was the second most frequent single task deficiency identified in the collisions in the study sample of accidents.

The principal factors identified in each type of accident are described separately. References are provided to the report pages containing the analysis results on which the findings are based.

Task Performance Factors in Collisions

The major task problem areas identified in the collisions studied are:

1. Failure of vessel-to-vessel communication when late detection was not a factor-- in just under 40 percent of the cases. Typically, no attempt was made by one or both vessels (pages 4-6 and 4-7 through 4-9).
2. Failure to maintain navigational position-- in 36 percent of the cases (pages 3-57 and 4-17 through 4-20). This was found to be associated with insufficient knowledge of vessel response characteristics, and also with current or wind as an accident factor. There were two typical scenarios involving failure to maintain position. In one, the most common, the vessel was forced out of position by environmental effects (e.g., current, wind, suction) while, apparently, a sound maneuvering plan was being executed. Often the person-in-charge attempted to compensate for the effects of environmental disturbances, but the

compensating action was insufficient, excessive, or not well timed. In the other common scenario (less frequent than the one just described), the report indicated that maneuvering was inappropriate and, as it turned out, infeasible. The vessel departed from a suitable course by choice of the person-in-charge; no environmental disturbance was reported to have been a factor.

3. Late detection of the other vessel-- in a third of the cases (pages 4-20 through 4-22).
4. Speed inappropriate for conditions-- in 20 percent of the cases. Excessive speed in fog was most common (pages 4-22, 4-23).
5. Failure to monitor the position and movement of the other vessel, when it was detected in time-- in 19 percent of the cases (pages 4-6, 4-27 through 4-29).
6. Incorrect evaluation of the navigational situation-- in 18 percent of the cases. This factor overlaps almost 100 percent with failure to monitor the other vessel, which indicates the nature of the evaluation error (page 4-30).
7. Failure to establish own navigational position properly-- in 18 percent of the cases (pages 4-30 through 4-32).

Failure by both vessels was found to be very likely in all of the foregoing task areas except maintaining position and inappropriate speed. This suggests that if at least one vessel is aware and taking prudent action, accidents may be avoided. If the task was a problem on only one vessel, it was usually the "primary vessel."³ It appears that awareness on the part of the larger, commercial vessels is critical.

In about half of the collision cases studied, one of the vessels was a small/special purpose vessel, such as a cargo ship of less than 10,000 GRT, a fishing vessel, or a recreational boat (pages 3-3, 3-10). In 18 percent

³ The primary vessel (PV) group in this study includes only ships of more than 10,000 gross registered tons or tugs/towboats with barges. The "other vessel" (OV) group might include any vessel. If both vessels in the collision fit the definition of primary, one was arbitrarily designated primary.

of those cases (9/50), the collision was attributed to irrational or irresponsible action by personnel on the small vessel. Only one collision was attributed to such action by personnel on a large ship or tug/towboat-barge array. Preoccupation of personnel on special purpose and recreational vessels was indicated. It also appeared in some cases that the small vessel personnel did not understand the dynamics of large vessel operation and acted imprudently out of ignorance .

In general, there are a variety of special hazards in the interaction of large and small vessels. They include, for example, the detectability of the small vessel and voice communication. The latter appears to be the most frequent problem area. Though most of the small vessels in the study sample of collisions were equipped for voice communication, just over half did not use their equipment (excluding cases in which the primary vessel was not detected; see page 4-13). It also was found that the larger vessels commonly did not attempt voice communication when the other vessel was detected.

It may be that the larger vessels tend not to attempt communication because they expect no response, because they assume lack of equipment or lack of knowledge of the uses and procedures of bridge-to-bridge communication, and perhaps because it seems irrelevant or somehow unsuitable to make passing agreements with certain kinds of small vessels (say, recreational or fishing vessels). Additional manipulation of the study data would help in evaluating this premise, at least partially. A thorough evaluation would require development or collection of new data about the exchanges within and between the categories of vessels during normal operations.

Accidents of this kind might be expected to cluster in areas where there is a lot of small vessel activity. On the other hand, the likelihood that a large and small vessel encounter will result in an accident may be greater when such encounters are rare and unexpected. Since half of the collisions involved large and small vessel encounters, the hazards ought to be explored in detail.

Relationships between Task Performance Factors and Environmental Conditions

Environmental factors were not frequently found to be involved with the task failures cited as collision causal factors. There are two exceptions,

excessive speed in fog (page 4-22), and current or wind with failure to maintain navigational position (page 4-19). Other associations were identified as follows:

- Obscuring condition of the natural environment (primarily fog or some other obscuring atmospheric condition, or a bend in the channel):
 - Positively associated with non-use of whistle signals to achieve passing agreement. That is, failure to signal intentions by whistle was likely to coincide with the existence of an obscuring condition as an accident factor (page 4-19).
 - Positively associated (94 percent confidence) with late detection on the part of the primary vessel (page 4-13); late detection by the OV was found to be equally likely regardless of impediments to visual perception.
 - When an obscuring environmental condition was not a factor, inappropriate speed of the other vessel was found to be positively associated with difficulty in seeing the primary vessel because of OV design or loading characteristics.
 - When an obscuring environmental condition was a factor, failure to properly establish own navigational position was closely related to being in an unusual/inappropriate location.
- Complex situation (one or more vessels not involved in the collision, or some other hazard, limited maneuvering options):
 - Positively associated with failure of the primary vessel to attempt bridge-to-bridge radio communication; positively associated with failure of OV to signal passing intentions by whistle (page 4-17).

Other Situational Factors in Collisions

The foregoing results concerning task performance failures were obtained by contingency analysis of a single section of the data from the

Casualty Analysis Gauge for collisions, the section dealing with task performance factors. Other data on various aspects of the accident situations were simply compiled. The incidence of the many possible combinations of these variables could not be studied within the scope of work. As noted previously, there are hundreds of thousands of combinations, so that even screening for relationships of possible importance is a large undertaking. However, some of the findings about individual situational factors appear to be important in themselves, and their relationships and associations with task performance should be examined:

- As previously discussed, half of the collisions involved a large ship or tug/towboat-barge configuration with a small/special purpose vessel (page 3-10).
- Seventy percent of the ships involved in the collisions studied were foreign-registered, whereas roughly 45 percent of those in the rammings and groundings studied were foreign-registered (page 3-15).
- Just under half of the ships in the collisions studied were diesel powered, versus roughly 30 percent in the rammings and groundings (page 3-16). Type of propulsion is related to registry as discussed on page 3-5.
- Twenty-seven percent of the collisions took place when visibility was less than $\frac{1}{4}$ mile. Extremely poor visibility was less common (13 percent) in both the rammings and groundings cases (pages 3-27, 3-28, 3-30).
- Nighttime collisions exceeded day collisions by 20 percent. Adding twilight collisions to those at night, the difference is increased to 27%; thus, a total of 63% of the cases studied occurred at times when environmental light was limited rather than ample. In this respect too, the collisions differ from the rammings and, to a lesser extent, the groundings (pages 3-28, 3-29, 3-35).

- In 25 percent of the cases, the radar was not in operation, although apparently in working order prior to the collision (pages 3-43, 3-48).
- In about 20 percent of the cases in which a determination could be made (326 cases out of the total 419), the vessel was in a sharp turn (> 20 deg) when the collision occurred (pages 3-42, 3-46).
- Meeting and overtaking encounters were most common, respectively, in 46 percent and 24 percent of the collisions (pages 3-43, 3-47).

Task Performance Factors in Groundings

Just over 60 percent of the groundings studied involved failure to maintain position resulting from:

1. Incorrect assessment of current force or, to a lesser extent, wind force. (This was called a problem in hazard "identification"-- i.e., in determining the nature/extent of the hazard with sufficient precision.)
2. Incorrect assessment of vessel response characteristics
3. A combination of the two.

In the first type of grounding, the person-in-charge attempted to compensate for the current (or wind), but the control change was insufficient. In the second type of grounding, where an environmental force was not a factor, the person-in-charge chose a path and/or speed that proved to be unwise, because of erroneous assumptions about what the vessel would do. Often the presence of one or more other vessels influenced the choice of course or speed, or made the choice unworkable.

These results are presented and discussed on pages 4-32 through 4-36. They support the findings in statistical summaries from the Coast Guard's Automated Vessel Casualty File.

It should be noted that "failure to judge the effects of wind, current, and tide" is so frequently used in the accident reports on groundings that it might be viewed as a catch phrase. However, based on study of the

of the descriptive information in the reports, the phrase seems apt, if generalized, and the frequency with which it is cited is believed to reflect reality.

There is another common grounding scenario, in which the vessel fails to detect a hazard, such as a shoal area or a submerged object. About 30 percent of the groundings were found to be of this kind.

Situational Factors in Groundings

Other data about groundings were compiled, but their relationships to task performance factors could not be explored. The following are selected items that appear to be of interest for further examination:

- Ships predominate over barge configurations in the study sample of groundings by a substantial margin (72 percent versus 28 percent, as shown on page 3-8). This is unique to groundings; the proportions of ships and barges were nearly equal in the collisions and ramming.
- Integrated tows were involved in a larger percentage of the groundings than of the other accident types (page 3-20).
- In 9 of the 18 barge groundings where the barge was being pulled on a hawser, the hawser length exceeded 300 feet; in 6 of those cases it exceeded 600 feet (page 3-21).
- One-third of the groundings took place when wind speed exceeded 10 knots. Sea swell over 4 feet was reported in 11 percent of the groundings (pages 3-28, 3-33, 3-34).
- Fifty-nine percent of the groundings occurred at night or twilight (pages 3-28, 3-35).
- Twenty-six percent of the groundings occurred when the vessel was negotiating a sharp (> 20 deg) turn (page 3-46).

Ramming Precipitating Factors

The principal ramming scenario is essentially the same as the principal grounding scenario. The outcome is different because of the physical hazards that are near (pages 4-37 through 4-40).

One difference is that combined effects of current and wind are reported in rammings whereas in groundings the two forces typically were not both cited in the same case.

Situational Factors in Rammings

- The ships involved in the rammings tended to be larger than those involved in the collisions and groundings (page 3-12).
- The barge configurations in the rammings were made up of two barges across more often than the barge configurations in the groundings and collisions (pages 3-17, 3-23).

The above findings point up the importance of geometry in rammings. The greatest opportunity for ramming obviously occurs during maneuvering in limited space, near some other physical object(s). The larger the vessel the less the margin for control error.

- The rammings divided roughly into thirds with respect to the object struck-- moored vessel, bridge or lock (the latter was rare in the sample), or dock. It should be noted that the bridge-related cases may include a few in which another object was struck while the vessel was negotiating a bridge. The questions asked did not make this distinction clear (pages 3-41, 3-42, 3-44, 3-45).
- More than half of the rammings at bridges were at drawbridges (page 3-42, 3-45).
- Thirty-eight percent of the rammings took place when the wind speed was in excess of 10 knots.

Exceptional Circumstances (pp. 3-50 through 3-53)

Equipment Failure. Ten percent of all of the accidents in the study sample were judged to be attributable primarily to failure of some part of the equipment by which control is effected, such as propulsion or steering equipment. Towing lines are included in this category of equipment. Navigational instrumentation is excluded.

The percentage of both groundings and rammings (12 percent) attributable to failure of control equipment is twice the corresponding percentage of collisions (Chart 3.33). This would appear to be because of the type of maneuvering situation (more restricted) in which rammings and groundings are more likely to occur as compared to collisions.

Irresponsible Behavior. Seven percent of the study sample of accidents was attributed primarily to irrational or irresponsible behavior by vessel personnel. Such behavior was defined to include being asleep or intoxicated, leaving an inexperienced person alone at the helm, or otherwise clearly abdicating responsibility for vessel safety. Cutting into the path of an oncoming vessel at close range is also included in this category.

This kind of problem was rarely observed in the groundings cases (2 percent). It was observed in 9 percent of the rammings and 10 percent of the collisions. In the rammings, the specific form of irrational/irresponsible behavior was excessive speed (Table 4.15). In 9 of the 10 collision cases attributed to such behavior, it occurred on a small craft or special purpose vessel, usually a recreational boat or fishing vessel (Chart 3.34).

Other Circumstances. There was only one case attributed to a "cataclysmic event," such as hurricane, sudden death, or illness of bridge personnel.⁴ Failure of navigational equipment was also only rarely reported as an accident factor (in four collisions, three groundings, and one ramming). Inspections of the operating condition and capabilities of navigational equipment, however, do not seem to be a routine part of the accident investigation process, so that equipment deficiencies are likely to be underestimated by the results of this study.

⁴ In that case, a tug-barge was caught in an extremely severe storm. The barge was loaded with radioactive waste for dumping. Although the storm was imminent-- in fact, because the storm was imminent --the tug operator felt he must try to unload the material at the dumping site rather than risk its being dispersed in the harbor.

CONCLUSIONS AND RECOMMENDATIONS

Major Problem Areas in Vessel Control Reliability

Three major problem areas are clearly indicated by the analysis results:

- Vessel-to-vessel communication-- in collisions
- Detection and monitoring of the position and movement of other vessels, especially when visibility is poor, at night, or when there is some other impediment to direct visual perception-- in collisions
- Maintenance of proper navigational position, especially against the effects of current and wind-- in all three types of accidents, but most frequently in groundings.

Several other common problem areas are suggested by the study data but could not be examined completely.

- Timely and accurate knowledge of own vessel position and safe path with respect to channel bounds and hazards, especially at night, when visibility is poor, and in bends or turns
- The interaction between large and small vessels. (Two particular kinds of problems in this category are expressed in the first two major problem areas listed above).
- The interaction between U.S. pilots and foreign vessel personnel. (This is tentatively suggested as a possible problem area because of the disproportion of foreign-registered vessels in the collisions as opposed to the rammings and groundings. Other explanations of this disproportion should be considered as well.)

Each problem area is discussed and possible solutions are discussed in general terms. Then recommendations as to possible preventive actions are discussed in detail for the three major areas documented by the analysis. A plan is also suggested for further investigation of the additional problem areas of possible importance.

Vessel-to-Vessel Communication

It was demonstrated in a previous study that bridge-to-bridge radiotelephone has been an effective anti-collision device on the inland waterways.⁵ The same degree of success is not evident in the harbor areas. (See pages 4-11, 4-12 for discussion).

It appears that 33 percent of the collisions studied could have been prevented by effective use of bridge-to-bridge communication. As stated in the findings section, the most prevalent problem in this area was not attempting communication.

Continuous monitoring of the channel is currently required on the vessels defined as primary in this study. A response when someone else initiates communication is also required by the regulations. The only requirement for initiation, however, is "when necessary." This guideline is apparently insufficient for many mariners in many situations, judging by the frequency of collisions wherein neither party attempts bridge-to-bridge radiotelephone communications. In addition, there are classes of "other vessels" which are not required to carry radiotelephones. Although the study data indicate that most small vessels do have some means of voice communication, the data also show that the available equipment is commonly not used when communication might have prevented the accident. Also, pilots may believe these "other vessels" are not equipped or will not respond, so that the pilots on vessels covered by the regulations may tend not to initiate communication, as is indicated by the study data.

Thus, it is recommended that an effort be undertaken to establish procedures for voice communication in harbor areas and that requirements or guidelines be set for when voice communication should be used.

If there is an appreciable amount of small vessel traffic or special purpose activity in a harbor area, and if traffic separation is not an option, procedures and rules concerning communication will have to take into account the training of the people operating such vessels, their purposes in being on the water, and the equipment that they can reasonably be expected to have onboard.

⁵ Stoehr et al., previously cited.

The roles of foreign vessel personnel in vessel-to-vessel communication also need to be examined. Pilots normally take their own handsets onboard and talk with other vessel personnel as they judge necessary. However, a pilot may not yet be onboard when the need arises, and there may be times when he could benefit by relying on vessel personnel to perform the communication so that he would devote attention to other vessel control requirements.

Use of Radar in Navigation and Collision Avoidance

Several of the study findings suggest that the use of radar may be a problem area underlying collisions: the incidence of night and twilight collisions; the incidence of collisions when visibility is less than $\frac{1}{4}$ mile; and the incidence of failure of one or both vessels to detect the other or to monitor the other's position and movement although it was detected in time; the incidence of failure to maintain navigational position as an accident precipitating factor; and the incidence of nonuse of radar (radar not on although the vessel had the equipment). Radar-related problems may include:

- Limited design capabilities of the equipment in use
- Poor operating condition of the equipment in use
- Personnel not recognizing when the equipment ought to be used
- Personnel not being skillful enough to utilize the equipment effectively.

The accident reports do not provide information detailed enough to assess the relative prominence of these specific problem areas. They do, however, suggest that such an assessment ought to be made.

It is recommended that equipment characteristics be surveyed on a sampling basis to determine whether radar is effectively available on the vessels engaged in coastwise and trans-ocean trade.

It is also recommended that an examination of radar training practices and the degree of fit between training practices and operating conditions (equipment characteristics and task assignments) be undertaken. This should include the maritime nations other than the United States.

Maintenance of Navigational Position

Knowledge of the Forces of Wind and Current. There are two principal sources of information on current direction and speed-- the Current and Tide Tables published by the National Oceanographic and Atmospheric Administration (NOAA) and reports that may be obtained from other vessel personnel, or in some areas, the Coast Guard Vessel Traffic Service or a harbor advisory service. Beyond those sources, the person-in-charge relies upon his direct visual perception of local conditions. Precise, real-time measurements of current characteristics are very rarely available.

To determine wind speed and direction, personnel rely upon mechanical indicators with which most vessels are equipped, and on their own direct perception.

It is not clear that more precise knowledge of these environmental forces would in itself lead to more reliable vessel control. Part of the problem seems to be insufficient knowledge of vessel hydrodynamic characteristics and maneuvering response characteristics, so that the person-in-charge cannot predict vessel behavior with accuracy sufficient for the situation. However, it appears that lack of adequate information about the forces themselves is at least part of this problem area which is prominent in both the ramming and grounding results, especially the latter.

The study results show that groundings typically occurred when an insufficient or inappropriate correction (or no correction) was made to compensate for current or wind effects. The same thing is true of ramming studies, but at least for ramming in highly congested areas, it appears that more precise information would not have permitted the maneuvers to be conducted successfully. There was typically, little time and space in which to compensate for the forces. The use of the information would be in deciding whether to attempt the maneuvers.

Cross currents and winds in bends are a special variation on the problem. The control actions required to maintain a safe path in negotiating a turn or bend in the channel appear to be subject to considerable uncertainty; if another vessel or obstacle, such as a bridge, is encountered in or close to the bend, avoidance can be difficult. It was found that 21 percent

to 27 percent of all three types of accidents occurred in a sharp turn (> 20 deg), considering only those cases in which a determination could be made (see page 3-46). The coincidence of sharp turn and current or wind as a casualty factor was not determined in analysis reported here, and should be determined.

It is suggested that, based on analysis of high accident areas, information can be furnished to the National Oceanographic and Atmospheric Administration so that tidal current reference stations might be set up in the more critical locations. These stations might be in addition to or instead of present stations.

In addition, it is recommended that an experiment be designed to determine the effects on vessel control of information on current and wind force and direction. The Netherlands Ship Model Basin has done some work on the effects of current information.⁶ Ten pilots participated in test runs on the ship simulator. Each pilot performed two trials under each of several current conditions, one trial with and one trial without advance knowledge of the current force and direction. Differences in deviation from intended trackline were measured. The pilots were divided into two groups of five so that the learning effect could be measured. One group performed the first trial for a given current condition with information and the second trial without; the other group did the reverse. Correcting for the sequence of trials in this way, it was found that the pilots were able to maintain intended track more closely when provided with information about the currents to be encountered.

A similar experiment was performed concerning wind in a study of operations at the Port of Valdez, Alaska.⁷ The same trend was observed.

⁶ P. J. Paymens and F. G. J. Witt, "Some Aspects of the Acquisition of Skills in Controlling Ships." Paper presented at the Symposium on Marine Transportation Systems, The Hague, 1976.

⁷ V. F. Keith, J. D. Porricelli, J. P. Hooft, P. J. Paymens, and F. G. J. Witt, "Real-Time Simulation of Tanker Operations for the Trans-Alaska Pipeline System." Paper presented at the Annual Meeting of The Society of Naval Architects and Marine Engineers, New York, N.Y., November 10-12, 1977.

Knowledge of Vessel Response Characteristics. In the analysis of collision reports, an attempt was made to establish the frequency of insufficient knowledge of vessel response characteristics on the part of the person-in-charge. No specific question about this type of performance problem was asked in the Casualty Analysis Gauge for rammings and groundings. Only a more general question was asked-- whether insufficient personnel training or experience was found to be a factor in the casualty. (The training/experience question was also asked in the collision CAG.) The ramming and grounding cases were analyzed and coded first. We recognized the ambiguity of the general training/experience question too late to include the more specific knowledge question in the rammings and groundings data. It was decided to include the more specific question in the collision CAG, although doing so created a discrepancy with the other data sets. Other questions are unique to collisions as well, although these differences were decided to be necessary because of the unique vessel interaction of collisions rather than because of late learning.

The person-in-charge was said to have insufficient knowledge of vessel response characteristics in 12 percent of the collision cases. When this finding was made, failure to maintain navigational position was almost always indicated to be the immediate task performance causal factor in the incident. The probability of error in assuming that these two factors are related was found to be .001 (Table 4.5, page 4-16.)

Typically, the person in charge called for what was found to be an unsuitable or infeasible maneuver based on an assumption about what the vessel would do. This was done almost always when collision was perceived to be an imminent threat (i.e., "in extremis," at least in the view of the person in charge.) It should be noted that an ineffectual or counterproductive control change might well be made in such a situation even if the person-in-charge were intimately familiar with the vessel response characteristics.

Insufficient knowledge of vessel response characteristics may also have been involved in many ramming and grounding cases, where an insufficient or unsuitable control change was made to compensate for current or wind, as previously discussed.

The environmental factors, current and wind, also appear to be involved in the collision scenario of insufficient knowledge resulting in failure to maintain position. However, the association of these two factors was found to be less certain when either current or wind was cited as a factor (Table 4.5, page 4-16). This highlights the kind of situation in which a finding of insufficient knowledge is most likely to be made-- namely when there is no alternative, when there is no apparent reason for the unsuitable or ineffective control decision other than lack of knowledge of vessel characteristics.

The judgment of insufficient knowledge is difficult to make, especially when the person in question is a master, mate, or pilot with many years of experience, as usually he was in the accidents studied. (In only 3 percent of the collisions cases and in only 3 percent of all accidents studied, was inadequate personnel training or experience cited as a factor.) It is believed that insufficient knowledge might well have been a factor in many more cases.

It is not believed, however, that the persons-in-charge should be labeled as poorly trained or ignorant. Most, if not all of those involved in the accident events studied probably had as much knowledge of the vessel response characteristics as their peers who were not involved in accidents and as much as they themselves had during their own accident-free port calls. The prediction of vessel response is far from a precise science. A number of interactive factors contribute uncertainty, including water depth, wind and current, proximity to a bank or fixed structure, and channel contour, in addition to vessel size, design and loading and the present functioning of its propulsion and steering systems. No one has precise knowledge of what a vessel is going to do in every particular situation.

The collisions in which lack of knowledge was found to be a factor may be a special subset of cases in which knowledge of vessel response characteristics was below the norm, or possibly in which the person in charge was flustered for some reason, or both. However, these cases also may be viewed as extreme instances of a more pervasive problem.

In 56 percent of all of the accidents studied, the person-in-charge was a special consulting pilot-- i.e., one who boards the ship for the purpose of taking it safely in and out of port. Forty-four percent of the accidents involved tug/towboat-barge arrays, on which a consulting pilot is not often used. The pilot has in-depth knowledge of the operating area and extensive ship-handling experience. However, he may not have been on the particular ship or even on a ship of the same class ever before. If he has, it most likely was several weeks or months in the past. Thus he lacks sure knowledge of even the vessel's basic maneuverability characteristics (e.g., radius of turn, engine response time), let alone how it will be affected by the particular circumstances to be encountered on the trip. In addition, the navigational instrumentation may not be familiar and/or may be out of adjustment, registering error for which correction must be made. There is little standardization of instrumentation, and inspections of navigational instrumentation by U.S. authorities are infrequent. The pilot gets information on these matters by looking around when he boards and by asking vessel personnel. There is likely to be a language barrier to full communication. The pilot may also make some trial maneuvers. However, he is still operating with a more or less unfamiliar vessel and equipment.

The Society of Naval Architects and Marine Engineers (SNAME), Panel H-10 (Controllability), has recognized the need of those in charge of vessel control for better information about basic vessel maneuverability characteristics. The panel has proposed a vessel information card to meet the need at least in part. The panel has been exploring the content and format of such a resource.

As the foregoing discussion indicates, it is not possible to determine conclusively from the study data whether insufficient knowledge of vessel response characteristics was a pervasive factor in the accidents studied. This factor was not explicitly cited in the majority of reports; yet from reading them we are convinced that explicit knowledge of vessel handling characteristics is a problem area of importance. It was also not possible to separate clearly knowledge of vessel handling characteristics from knowledge of environmental forces, as we had hoped to do. Additional

experimentation along the lines of the NSMB work previously cited, could help to clarify this question. It is more probable that improvements in both areas are needed.

Prompt and accurate feedback about vessel behavior would appear to be helpful in both problem areas. Although control decisions must be made well in advance, (so that real-time feedback has its limitations), a vessel does not get out of position suddenly. If deviation from intended track can be perceived immediately, then it is more likely that corrections will be made in time.

The primary concern in the channel approach to a harbor is to know the ship's transverse position in the channel. This is normally determined by means of range lights or by observation of, or position-fixing on, available reference points. When visibility is poor, when visual perception is impeded by some obstacle, and at night, these means may be inadequate. An equipment solution is used by pilots in Rotterdam, they carry onboard a "precise navigator" (referred to as the "brown box") that works in conjunction with the installed Rotterdam Decca System. This provides the pilot with a visual display of the ship's path in relation to the channel boundaries. The use of a system of this kind should be given serious consideration.

Solutions to the Problems

Communication Procedures. The existing regulations and procedures for bridge-to-bridge radio communication might be strengthened by adding guidance as to when communication should be undertaken and by including additional classes of vessels in the communication requirements. Any modifications undertaken, however, must be carefully evaluated before introduction, to avoid introducing greater problems. For example, in a harbor area with a great deal of recreational activity, a requirement to communicate with any such vessel in a range of x miles would create a burden and cause confusion. Some combination of vessel traffic services, a separation scheme and restricted zones for recreational vessels appears to be needed in such areas. The proper combination must be evaluated for each individual port.

Communication Training. The questions of when voice communication should be undertaken, by whom and with whom, appear to be most critical in

light of the study results concerning collisions. However, it is also likely that vessel personnel, especially unlicensed operators, might benefit by guidance in the content and procedures of effective communication for collision avoidance. This is a training solution, and means of delivering such training need to be worked out. It may be sufficient just to include the guidance in regulations and associated educational materials published by the Coast Guard.

The training content is certainly not difficult, but as far as we know, no instructions about what information vessels ought to give each other have been formally produced. It seems to be assumed that everyone knows what to say as a matter of common sense. Perhaps this is true. The accident reports do not show a great many instances of misunderstanding when communication was attempted. Nevertheless, it seems reasonable that some standardization of what is conveyed, and the language used, would be helpful.

For example, observations of study team members and comments of vessel personnel indicate widespread lack of discipline in the use of Channel 13. This channel (also Channel 16 in some areas) is required to be monitored and personnel are supposed to switch to another channel for discussion. It appears, however, that conversation routinely is conducted on Channel 13.

Research. Further analysis of data from this study could help to clarify the problem to some extent:

- Communication problems should be examined by vessel categories—vessels larger than 10,000 GRT, tugs/towboats, and small or special-purpose vessels
- Communication problems among U.S.- and foreign-registered ships should be compared. The category of person in charge should be checked.

Another type of useful and relatively economical research would be to monitor and document the vessel encounters and, if possible, the associated communications, in areas where there is a vessel traffic service employing radar. This would establish, at least for those areas, an encounter rate, which would make it possible to evaluate the voice traffic problems that might attend more use of bridge-to-bridge communication. If the communications could be monitored, an evaluation could be made of information quality

as well as channel use discipline. Additional personnel might have to be assigned to perform such a project so that the VTS could continue to fulfill its responsibilities.

Hazard Detection and Monitoring—Collisions. Training and equipment improvements are the most appropriate solutions for these types of problems as collision factors. However, additional study is needed before actions can be well directed. Four projects are recommended:

1. Inventory the navigational equipment on commercial vessels, on a sampling basis, taking into account vessel types, size, and registry. Radar, in particular, is of concern. Document the differences in location, operating procedure, and display for the equipment types. Establish intrinsic operating capabilities and condition.

The above information would show what vessel personnel have to work with, which is believed to figure in this problem area. The information would allow plans to be worked out for improving equipment effectiveness and standardization. The latter should be of particular value to harbor pilots.

2. Conduct a comparative review of training in instrument navigation and collision avoidance provided by the maritime nations.

The training review would, for example, indicate the expected actual proficiency of the personnel who may function as radar operators.

3. Examine the interface between special consulting pilots and vessel personnel.

A special aspect of the work situation when a pilot comes aboard is the pilot's perceptions of the proficiency of vessel personnel as radar operators and in other functions of vessel control. Pilots may be reluctant to rely upon vessel personnel, and in some circumstances may be unable to cover all of the watchkeeping and communication requirements as completely and continuously as they might like them to be covered. Such problems may be particularly likely on foreign flag vessels because of language differences and cultural unfamiliarity.

The foregoing is speculative but could figure in the task omissions noted in the collisions studied. The study results do not indicate task overload as a frequent problem area. This may be because task overload is not thought of in this way, or not reported for other reasons. Neither was language barrier shown to be a substantial problem; but it could be that potential language difficulty is being avoided by pilots functioning essentially single-handedly.

One way of evaluating such potential factors is to ask pilots to record, after each run, the status of the navigational equipment onboard; the job categories of the vessel personnel assigned to watchkeeping functions; whether the pilot felt that those individuals could be relied upon to provide timely, accurate, and useful information; and whether the pilot did in fact utilize those individuals in the conduct of his work.

4. Analyze additional data from this study.

Although this recommendation is listed last, it probably should be acted upon first. A limited number of additional comparisons of study variables could help to clarify the nature of the problems in detection and monitoring. The following should be done:

- Compare the task performance problems in collisions and night and when visibility was less than 1/4-mile to collisions in the day and with good visibility. Also, an effort should be made to determine the volume of all operations under these conditions. Here the vessels of primary concern in this study should be separated from the other vessels.
- Compare the task performance problems of U.S. and foreign registered ships, further classified on visibility/available light as above.
- Compare the task performance factors on ships and tug/towboat-barge arrays.

Environmental Forces and Position Maintenance. Work needs to be done to evaluate the benefits of improved information about current effects

in particular. Experiments for this purpose were previously described and cited. Additional experimentation to confirm the findings would be beneficial.

Another form of evaluation has been explored—mathematical modeling of operator behavior in various operational scenarios with various amounts and forms of information. This is difficult, but it appears to be feasible to develop the necessary concepts and mathematics, beginning with a fairly simple scenario. Such a capability would provide a highly efficient means of testing the effects on performance of variations in the kinds, quantity, timing, display, and precision of navigational/maneuvering information.

In terms of operating solutions, it is recommended that high frequency accident areas be evaluated for current anomalies and their relationships to other factors such as channel contour, water depth, and tidal stage. Then specific sites where currents are particularly hazardous can be identified so that readings can be taken and relayed to vessel personnel. Current and weather information could be coordinated and relayed by the vessel traffic service, where one exists.

Additional Comments

The expected effectiveness of the solutions proposed here can only be evaluated by their relevance to major problems. Using that criterion, there is much to be gained.

A commonly proposed solution is to enhance vessel maneuverability by increasing horsepower. The study results do not suggest that this would be productive, except that wider use of bow thrusters would help to reduce the incidence of accidents involving ships, and also barge arrays of the push variety. This solution is applicable to the large number of cases involving failure to maintain position at low speed. The potential for ramming while docking, in particular, could be reduced by this means.

It is probable that none of the proposed solutions alone would lead to large reductions in the occurrence of accidents. The combined effect, however, could be very substantial. We believe that the hope of eliminating a large number of accidents by a single, generally applicable safety initiative is illusory. The system is dynamic and complex, and it must be considered as

as whole. It seems inevitable that various adjustments will be needed, in several aspects of the system, to increase performance reliability.

Finally, accident prevention in a living system must be recognized to be a continuing process. So must identification of safety problems. As the system changes, the problems and appropriate solutions change.

ORGANIZATION OF THE REPORT

This volume contains, in Section II, a description of the study objectives, procedures for data base development, and analysis methods. The tallies of yes answers to the questions asked in the Casualty Analysis Gauges are presented in histogram form and discussed in Section III. The tallies show the number of times a condition or factor was indicated to exist before the accident occurred. Comparisons are made between accident types. In Section IV, relationships between a subset of these conditions or factors are discussed, based on cross tabulation and statistical testing of association involving pairs and triads of variables. The volume also includes an appendix in which the Casualty Analysis Gauges are presented.

The raw data created by CAG review of the accident reports are stored on a single magnetic tape. In addition, all of the comparisons of data and estimates of the statistical significance of their relationships are stored on magnetic computer tapes. A standard commercial set of computer programs called the "Statistical Package for the Social Sciences (SPSS)" was used for this analysis. Computer instructions for putting the raw data into the formats required by SPSS are on one tape with the raw data. There are, also, five tapes containing outputs of the analysis: one each for ramblings and groundings, and three for collisions. On these tapes, the estimated statistical significance values of the data relationships are listed in order of significance. This allows analysts who may want to examine only the closest relationships to find the comparisons of interest. The main outputs on these tapes are tables showing the numbers and percentages of cases in which specific factors were related to each other in certain ways. Instructions on reading and interpreting these tables can be found in the appendix to the report, with the Casualty Analysis Gauges containing the specific questions analyzed. Paper copies (computer printouts) of all the data, significance listings and tables were provided to

the Coast Guard Office of Research and Development in seven separately bound volumes, along with the magnetic tapes.

II. DESCRIPTION OF THE STUDY

This is a study of vessel accidents in harbors and harbor entrance areas. The study deals with accidents involving ships of at least 10,000 gross registered tons (GRT) and barges moved by tugs or towboats. Accidents involving these classes of vessels in harbor areas are of particular concern because of the potential magnitude of the damage that may result, including environmental damage as well as personnel injury and property loss.

The accidents considered are those resulting from loss of vessel control: collisions, rammings, and groundings. Collision is defined in this study as a striking of two or more vessels that are independently underway. Ramming is defined as the striking of a fixed or unpowered object, natural or man-made, by an underway vessel. (For example, an iceberg, buoy, vertical bridge support, or another vessel anchored or moored could be the struck object in a ramming.) Grounding is defined as the stopping of an underway vessel by contact with the bottom of the waterway.

Collisions, rammings, and groundings occur more frequently than other types of major marine accidents such as explosion, fire, and structural failure. Moreover, the processes leading to collisions, rammings, and groundings have been difficult to define, since vessel control depends on the interactions of vessel maneuverability characteristics, variable environmental conditions, human operator behavior, and constraints and uncertainties introduced by other traffic.

BACKGROUND

Conceptual Antecedents

Despite the complex dynamics of vessel control, it has been thought that there might be some relatively small number of major causal factors, or combinations of factors, operating in many accidents. If these could be identified and eliminated, a large number of accidents might be prevented.

Several studies have been performed in the past five to six years with the aim of clarifying causal factors in maritime accidents. In general, no significant trends were demonstrated except for the high level categorization of human error. Human error was found to be a principal factor in some 60% to 80% of vessel accidents in these studies.¹ However, it was difficult to identify patterns in specific types of error, such that solutions might be evaluated. A framework was needed for systematic analysis of human error.

In 1975, the Coast Guard began working to create a sound functional framework of the tasks performed by mariners. Analyses were performed in which the basic functions of vessel control were specified, along with the equipment interfaces and the training required for each task.² Both ship and towboat-barge operations were analyzed.

Two other, non-accident studies were also important precursors of the present work:

¹ W. Dunn and P. Tullier, Spill Risk Analysis, Phase II: Methodology Development and Demonstration. Silver Spring, Maryland: Operations Research, Inc., for the U.S. Coast Guard Office of Research and Development, November 1975. NTIS AD 785 026. Maritime Transportation Research Board, Human Error in Merchant Marine Safety. Washington, D.C.: National Academy of Sciences, June 1976. C. Cordell and R. Nutter, Shiphhandling and Shiphhandling Training, U.S. Navy Training Analysis and Evaluation Group Report No. 41. Orlando, Florida: Naval Training Equipment Center, December 1976. L. Stoeher et al., Spill Risk Analysis Program: Methodology Development and Demonstration, Volume I. Silver Spring, Maryland: Operations Research, Inc., for the U.S. Coast Guard, Office of Research and Development, May 1977. U.S. Coast Guard Report No. CG-D-21-77. NTIS AD A-43054.

² J. Smith et al., Task Analysis of Vessel Control, 3 vols. Silver Spring, Maryland: Operations Research, Inc., December 1976. U.S. Coast Guard Report No. CG-D-1-77. NTIS AD A-37316.

- a study of pilotage in confined waterways, in which data were obtained through onboard observation and real-time pilot self-reports of the processes of vessel control;³
- a Swedish study in which a functional model of vessel control was proposed as a means of analyzing and improving vessel handling system reliability.⁴

These two pilotage studies, like the task analyses, depict vessel control as an information-processing/decision-making activity. Acquisition, integration and interpretation of information are shown to be the predominant activities. A premise of all three studies was that to prevent accidents it is necessary to understand the human activity in normal navigation/maneuvering as they may be complicated by situational variables. The Swedish study speaks of situation-caused versus human-caused error in vessel control. This distinction makes a useful first-order classification of accidents and reminds us that human error is not synonymous with carelessness, recklessness, inferior capabilities, and the like.

Methodological Antecedents

The study of accidents in harbors makes use of the Quasi-Experimental Method (QEM) developed and demonstrated in the Spill Risk Analysis Program.⁵ "Quasi-Experimental" is a term used to denote various strategies for data analysis and hypothesis testing to maximize the validity of field research in which direct manipulation and observation of experimental variables under controlled conditions are not possible.⁶

³ J. Huffner, Pilotage in Confined Waterways of the United States: A Preliminary Study of Pilot Decision-Making, Linthicum Heights, Maryland: The Maritime Institute of Technology and Graduate Studies, July 1976. U.S. Coast Guard Report No. CD-D-96-76, NTIS AD A029715.

⁴ H. Istance and T. Ivergard, "Ergonomics and Reliability in Ship Handling Systems - Theories, Models and Methods." Paper presented at the Fourth Ship Control Systems Symposium, Den Helder, The Netherlands, October 1975.

⁵ L. Stoehr, et al., previously cited.

⁶ Elements such as the times at which experimental variables are introduced, to whom they are introduced, and the conditions under which they are introduced.

The Spill Risk QEM was suggested in a comparative survey of experimental and quasi-experimental designs, written by Professors Donald T. Campbell and Julian C. Stanley and published in 1963.⁷ Since then, the literature available to guide the conduct of research under field or nonlaboratory conditions has been augmented significantly.⁸

Quasi-experimental designs have been widely used in the social sciences where ethical, political, and time and cost constraints often make classic experimentation impossible. However, the promise of quasi-experimental techniques for the study of marine safety questions has not been widely recognized. To our knowledge, the Spill Risk Program provided the first explicit demonstration of the use of QEM in the marine safety field.

STUDY OBJECTIVES

The Coast Guard statement of requirements for the study defines the objectives as follows:

- To screen reports of collision, ramming, and grounding accidents in harbors and entrances for any consistent patterns of causal factors, relating the factors to specific components of the Task Analyses previously conducted.

⁷ Experimental and Quasi-Experimental Designs for Research. Chicago: Rand McNally College Publishing Company, 1963. The survey appeared originally in Handbook of Research on Teaching (N.L. Gage, editor), published by Rand McNally in the same year.

⁸ See, for example, T. Cook and D. Campbell, "The Design and Conduct of Quasi-Experiments and True Experiments in Field Settings," in Handbook of Industrial and Organizational Psychology (M. Dunette, editor). Chicago: Rand McNally College Publishing Company, 1976. Also, D. Campbell, "Assessing the Impact of Planned Social Change," in Social Research and Public Policies, The Dartmouth/OECD Conference (G. Lyons, editor). Hanover, New Hampshire: University Press of New England, 1975. D. Campbell, "Measuring the Effects of Social Interventions by Means of Time Series," in Statistics: A Guide to the Unknown (J. Tenen et al., editors). San Francisco: Holden-Day, Inc., 1972. E. Webb, D. Campbell, R. Schwartz and L. Sechrist, Unobtrusive Measures: Nonreactive Research in the Social Sciences. Chicago: Rand McNally College Publishing Company, 1966.

- To evaluate, simultaneously, major proposed (trial) solutions, such as computerized collision avoidance radar systems, "improved maneuverability," and specific training in aspects of harbor navigation.

These objectives call for a comprehensive survey of casualty experience to identify factors present in relatively large numbers of casualties and to determine the general applicability of potential solutions.

METHODS

This is an exploratory data analysis making use of historical records. The data were taken from the archive of accident investigation reports maintained by the U.S. Coast Guard. The reports consist of forms and, in some instances, narrative descriptions by vessel personnel and/or the Coast Guard investigating officer.⁹

The Accident Population

A five-year reporting period was selected, FY 1972 through FY 1976. The study population of accidents was defined to include all collisions, ramblings, and groundings that occurred in harbor areas during those years and involved ships of more than 10,000 gross registered tons or tug/towboat-barge configurations. The cases in the population were identified by obtaining listings from the Coast Guard's computerized casualty information system, the Automated Vessel Casualty File. A total of 1,345 vessels greater than 10,000 GRT were shown in this file to have been involved in harbor area accidents reported FY 1972 through FY 1976. Two duplicate listings were found, bringing the total to 1,343. In addition, 2,046 barge involvements were found. There is some overlap between these two groups; the vessels greater than 10,000 GRT were found to include 81 barges, which would be included in the barge casualty listing, plus 9 tugs/towboats. The latter might be represented in the barge listing if they were moving barges at the time the accidents occurred. Subtracting the 81 barges from the data set for vessels greater than 10,000 GRT leaves a total of 3,308 vessel involvements. The total number of separate

⁹ "Narrative" is used by the Coast Guard to designate a specific type of accident report in which the investigating officer prepares a memorandum of information according to a set format. Unless otherwise noted, the word narrative is used in the general sense in this study.

collisions, rammings, and groundings (as represented by unique case numbers) between these two listings is 2,776.

There could be error in the number of separate cases because of the 9 tugs/towboats, as explained above, and also because of the way the barges in collisions were counted. When two or more barges were listed by the same case number, they were treated as part of a single array. Some of these, however, could be separate barges/arrays which collided. In the Coast Guard file, the data on each vessel in a given accident constitute a separate record, but all of the vessels are assigned the same case number. It is necessary to read the written reports to sort out the vessels, especially in collisions. The error in number of population accidents is believed to be quite small. Moreover, the tugs/towboats in the listing of vessels >10,000 GRT would increase the number, while the treatment of multiple barges would decrease it. The two potential error sources reduce if not cancel each other.

The Study Sample

The study sample was drawn on the basis of the amount of information in the accident report. The Automated Vessel Casualty File contains coded information from the accident report form, CG 2692, "Report of Vessel Casualty or Accident." This form is completed by the person in charge of the vessel and/or a representative of the operator at the time of the casualty. When a report provided no information other than the information on the 2692, the case was excluded from the study sample. This was done because too many of the data elements sought in the study cannot be obtained from the 2692, and statistical summaries of the items it contains are already available through the Coast Guard's automated file. When a report contained a descriptive statement, a map or any useful amount of information to augment the form 2692, the case was included in the sample.

The identified reports, stored on microfilm, were scanned to determine whether the case was in fact in the population and whether the information appeared to be sufficient for study purposes. This was a large task, especially

since the microfilmed archive includes all reported casualties/accidents involving all kinds of vessels, in all U.S. navigable waters coastal and inland, not just the cases in the study population. The selected case reports were then copied for close study. When they were examined in detail, additional cases were rejected for reasons such as illegibility of essential information, primary vessel not identified, no causal information given. Finally, minor bumps between a tug or towboat and the vessel being assisted and other kinds of minor contact between vessels within an individual configuration, were excluded from the collision sample, as were rammings and groundings by vessels anchored, moored, or adrift.

The final study sample includes 419 cases -- 15 percent of the population initially identified in the listings from the Automated Vessel Casualty File. Figure 2.1 compares the sample and population distributions of collisions, rammings, and groundings. It shows that the sample is very like the population in mix of accidents. The sample is slightly weighted with collisions. This suggests that we tended to draw the more severe accident cases using the criterion of amount of narrative information. This is reasonable since more explanation can be expected in more severe cases.

Figures 2.2 and 2.3 compare the types of vessels involved in the sample and population accidents. In Figure 2.2, ships are shown to be very substantially overrepresented in the sample groundings and rammings. That is another indication that the sample tends to include the more severe accidents. In Figure 2.3, however, an opposite tendency is suggested, although it is not marked; the sample is weighted slightly with accidents involving barges. This is believed to have happened because of the "Towing Addendum," which is an additional form used in reporting tug/towboat-barge accidents. This form includes very useful data elements. (Its use was discontinued in FY 1976, which is believed to be a significant loss for the casualty/accident data base.)

Figure 2.4 compares the cargo types of the vessels in the population versus the sample accidents. Again they are shown to be quite similar.

It is concluded that although the study sample was not randomly drawn, it does represent the population of commercial vessels that are of concern in the study. The sample appears to be weighted toward the more

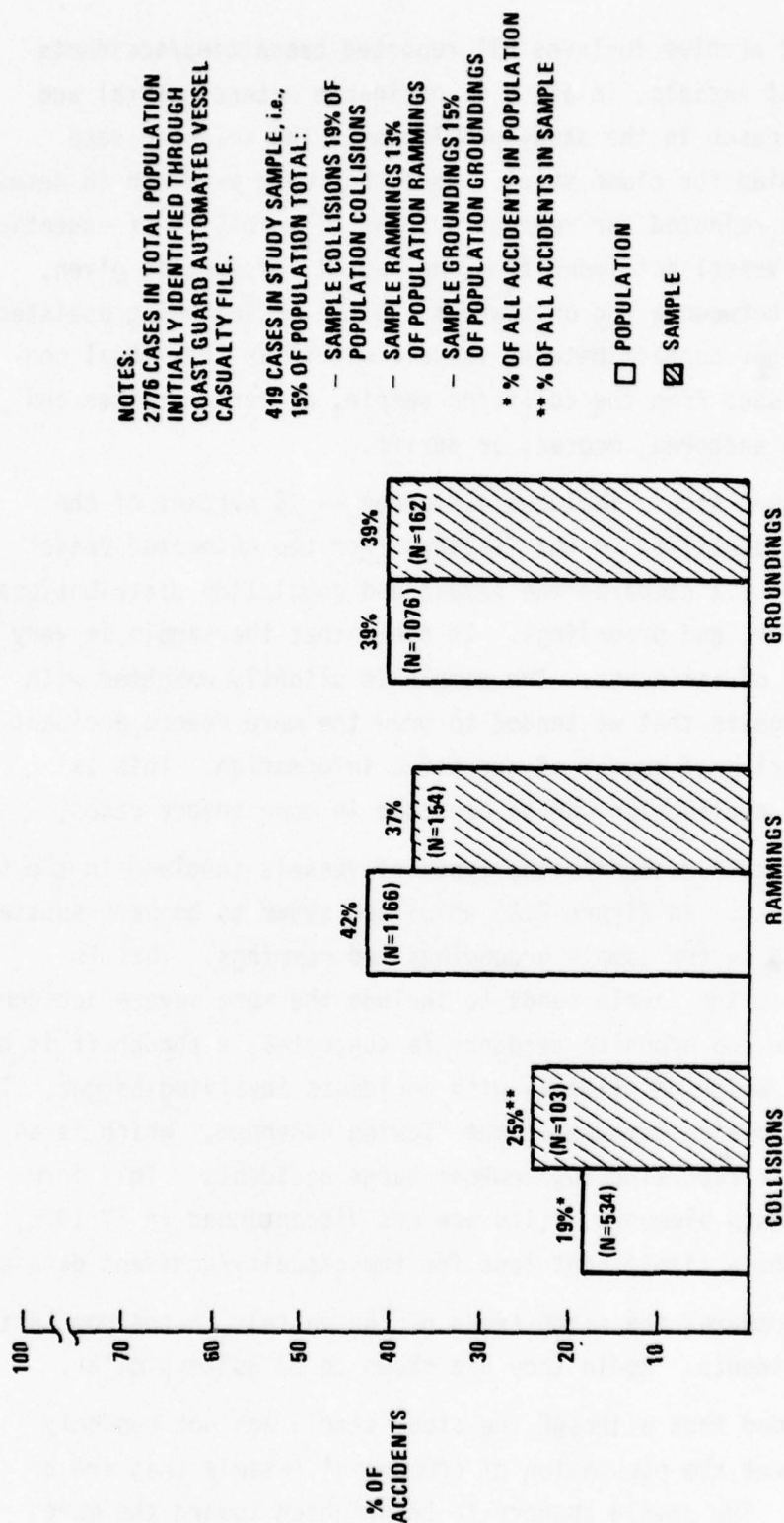


FIGURE 2.1. DISTRIBUTION OF COLLISIONS, RAMMINGS, AND GROUNDINGS:
COMPARISON OF SAMPLE TO POPULATION

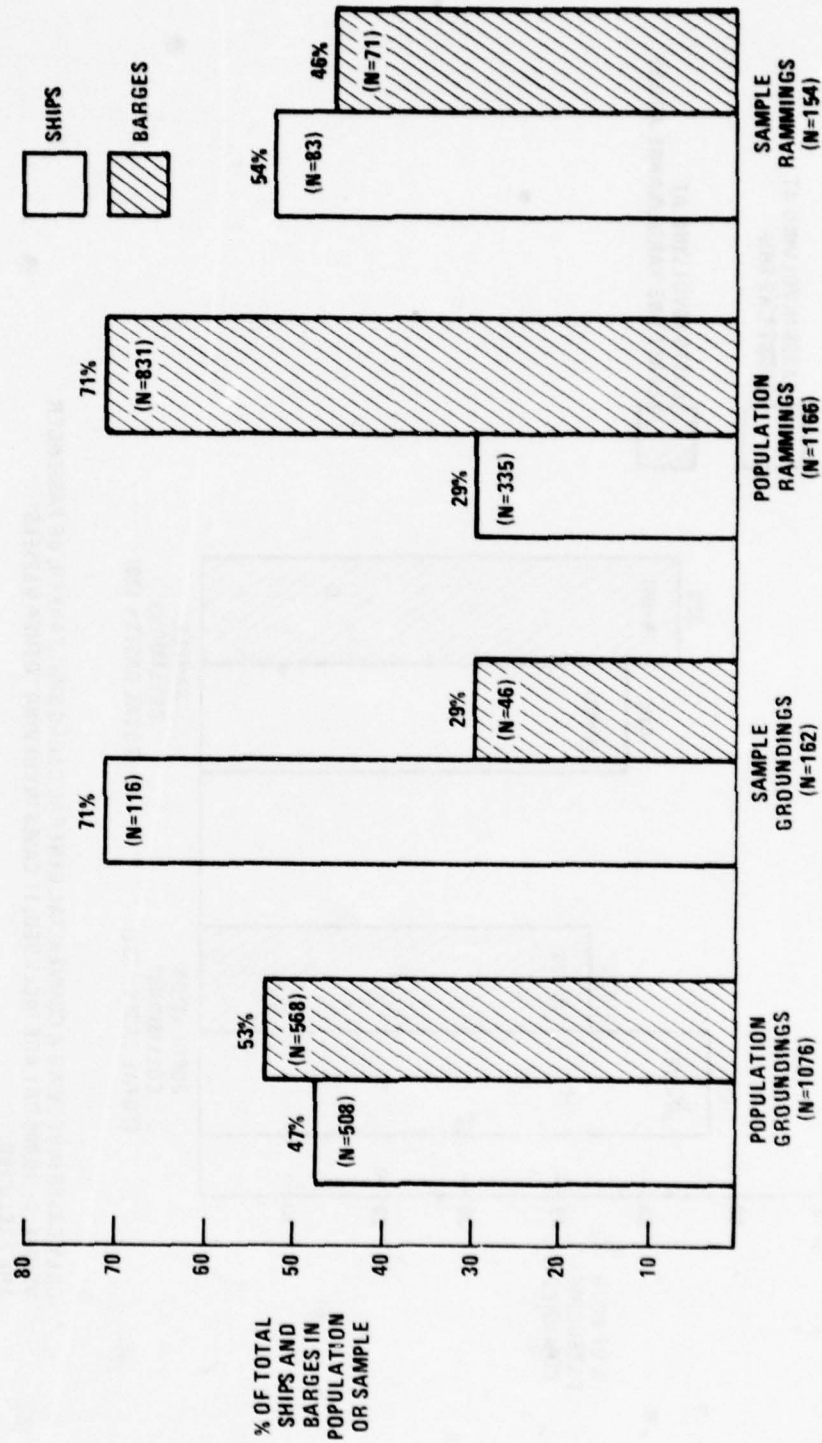


FIGURE 2.2. SHIP AND BARGE INVOLVEMENT IN GROUNDINGS AND RAMMINGS: COMPARISON OF SAMPLE TO POPULATION

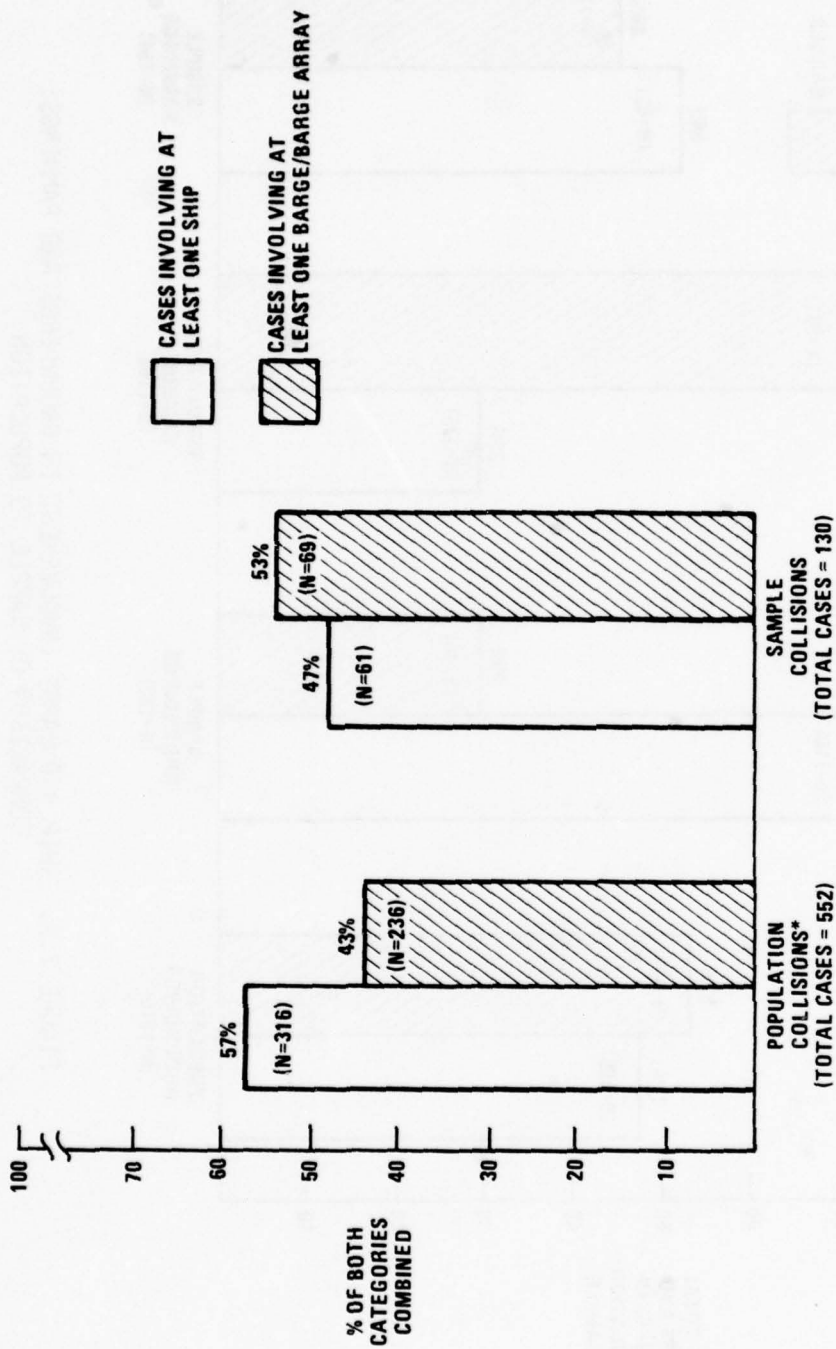
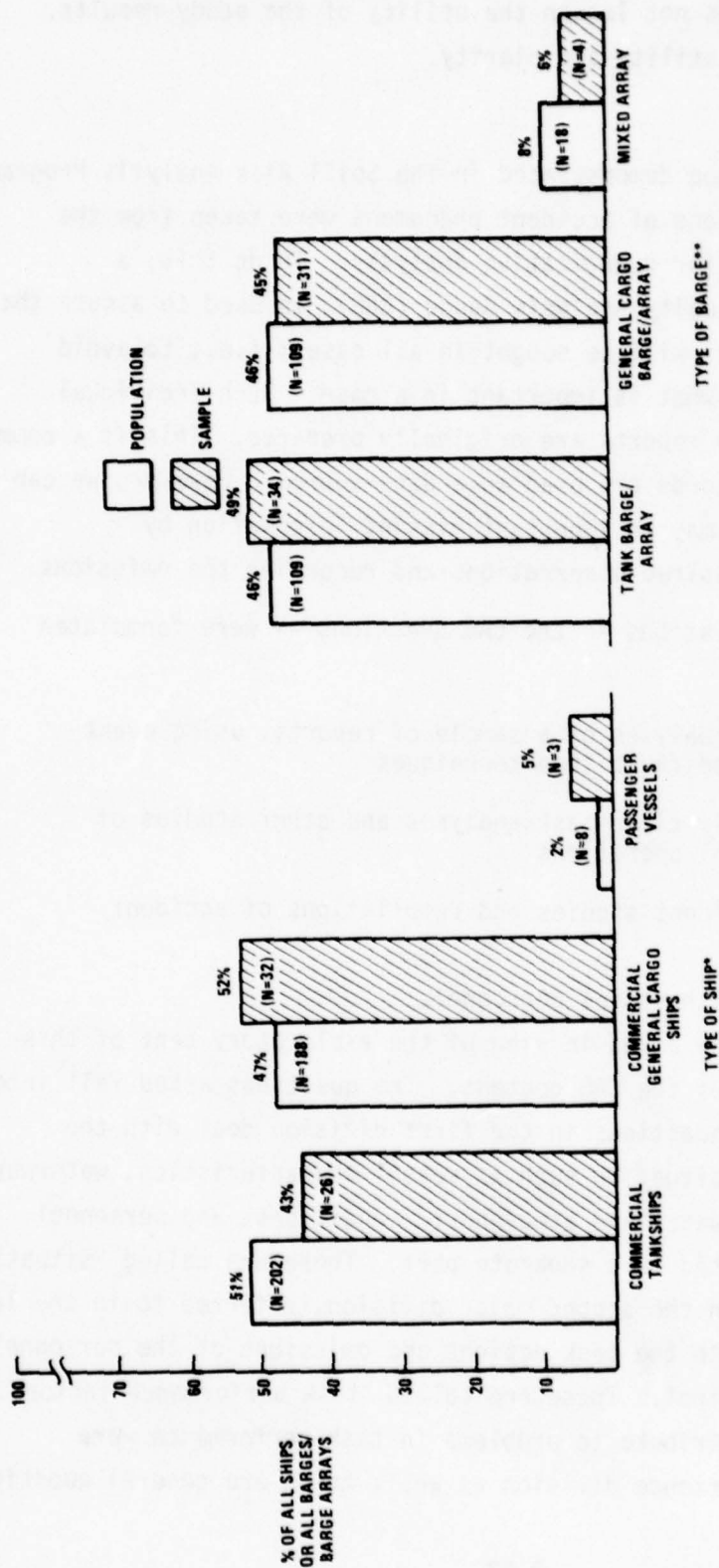


FIGURE 2.3. SHIP AND BARGE INVOLVEMENT IN COLLISIONS:
COMPARISON OF SAMPLE TO POPULATION



* POPULATION TOTAL = 398; EXCLUDES 11 "OTHER" VESSEL >10,000 GRT IDENTIFIED IN POPULATION.

SAMPLE TOTAL = 61.

** POPULATION TOTAL = 236. THIS IS AN UNDERESTIMATE WHEN TWO OR MORE BARGES WERE LISTED WITH THE SAME CASE NUMBER, THEY WERE COUNTED AS A SINGLE ARRAY, ALTHOUGH THEY MAY HAVE BEEN PART OF SEPARATE BARGE CONFIGURATIONS THAT COLLIDED. HOWEVER, CONSIDERING EACH BARGE AS AN INDIVIDUAL UNIT, THE RELATIVE PROPORTIONS OF CARGO TYPES FOR THE POPULATION ARE VERY SIMILAR TO THE PROPORTIONS SHOW HERE: 52% GENERAL CARGO AND 48% TANK. SAMPLE TOTAL = 69.

FIGURE 2.4. RELATIVE PROPORTIONS OF CARGO TYPES FOR SHIPS AND BARGES: COMPARISON OF SAMPLE TO POPULATION

severe accidents. This does not lessen the utility of the study results. Rather, it increases their utility and clarity.

Data Development

Following the method demonstrated in the Spill Risk Analysis Program previously cited, observations of accident phenomena were taken from the reports in a form suitable for quantitative analysis. To do this, a questionnaire, called a Casualty Analysis Gauge (CAG), is used to assure that the same set of observations will be sought in all cases; i.e., to avoid individual decisions about what is important in a case. Such individual decisions are made when the reports are originally prepared. This is a common problem when historical records are used as a data source. However, we can at least remain aware of what may be important missing information by specifying a full set of desired observations and recording the omissions.

The desired observations -- the CAG questions -- were formulated based on

- preliminary analyses of a sample of reports, using event sequencing and fault tree techniques
- the previously cited task analyses and other studies of vessel control operations
- previous accident studies and compilations of accident statistics
- interviews with vessel personnel.

Many questions were asked in view of the exploratory bent of this study. Table 2.1 summarizes the CAG content. The questions asked fall into two major divisions. The questions in the first division deal with the elements of the operating situation such as vessel characteristics, waterway characteristics, variable water and atmospheric conditions, and personnel characteristics, each treated in a separate part. These are called "situational factors." The questions in the second major division, referred to in the last item on Table 2.2, deal with the task actions and omissions of the personnel responsible for vessel control. These are called "task performance factors." Conditions which might contribute to problems in task performance were included in the task performance division as well; these are general questions

TABLE 2.1
OVERVIEW OF HARBOR CASUALTY ANALYSIS GAUGE CONTENT

Vessel Characteristics Indicators of Baseline Maneuverability	
<ul style="list-style-type: none"> - Type (ship, tug/towboat-barge configuration) - Basic Design (tank, general cargo vessel, etc.) - Length - Tonnage - Number of barges, etc. - Use of assisting Vessels 	
Waterway Characteristics	Fixed constraints on maneuvering-define the basic maneuvering problem
<ul style="list-style-type: none"> - Channel width, depth relative to vessel draft, beam - Turns - Structures (e.g., bridge, lock) 	
Traffic Density and Mix, Traffic Patterns	
Variable Environmental Conditions	More or less transient
<ul style="list-style-type: none"> - Current direction relative to vessel - Wave height and direction - Wind direction and speed - Meteorological conditions 	
Personnel Characteristics	Indicators of degree of capability to meet requirements
<ul style="list-style-type: none"> - Types - Experience - Training - Present state (e.g., indicators of fatigue) 	
Resources for Vessel Control	Sources of information for determining present vessel control status and predicting future state
<ul style="list-style-type: none"> - Navigational instrumentation - Propulsion and steering capability 	
	Means of effecting control
Task Performance	Given the resources, what was done/left undone

representing detailed situational questions asked earlier which might help in evaluating the importance of the detailed situational factors. A few additional questions which did not fit in the situational parts of the instrument were also asked among the task performance factors. One CAG was developed to cover both ramming and groundings. A separate instrument was needed for collisions because more than one vessel is actively involved. The Casualty Analysis Gauges are presented in an appendix, Volume II of the report.

Initially, each report was read and coded by at least two independent readers. Agreement rates were computed to test the reliability of the instrument and procedures. Agreement between study team personnel with marine backgrounds was determined first. Then their answers were compared with those of other personnel who had no experience with commercial vessel operations.

In this process, ambiguities and inconsistencies in question wording were identified. Questions were modified and agreement checks performed again.

The agreement rate was 84% for the parts of the CAGs that were designed to establish the elements of the accident situation. The agreement rate for the parts designed to draw conclusions about task performance factors was higher - 96%. The overall agreement rate was thus on the order of 90%.

The lower rate for the situational factor parts is believed to have occurred for two reasons. First, "No Data" and "Not Applicable" answer choices were provided in those parts; the agreement rates are reduced by differences of opinion involving those choices. (There were no such choices in the parts of the CAGs which address task performance factors.) Second, some readers tend to answer questions based on indirect evidence more frequently than others. The rule was to code No Data if the report did not provide solid evidence; it was also the rule not to apply knowledge from sources other than the accident report (e.g., knowledge of the area in which the accident occurred). However, a few discrepancies crept in.

Overall, it is believed that the reliability achieved is excellent considering the length and complexity of the Casualty Analysis Gauges.

Analysis Design and Procedures

Vessel control accidents rarely if ever result from a single "cause." A set of circumstances occurs which might be altered in several ways to avoid the accident. The set usually includes environmental, personnel, and vessel/equipment factors. The following example is from one of the accident reports in the study:

Case 31806: Tug pushing loaded barge

1. Tug and barge navigating upriver, proceeding towards railroad bridge.
2. Heavy squalls set in 1/2 mile from bridge; visibility approaching zero.
3. Tug master takes vessel out of gear; drifts ahead slow.
4. Master regains sight of bridge.
 - a. Vessel has drifted to west of river.
 - b. Barge and tug are not properly lined up to pass through bridge.
5. Master estimates that applying hard right rudder will allow safe passage without backing down and realigning tow.
6. Maneuver is unsuccessful; current sets tug and tow against west fender works of bridge.

There might have been no accident ...

- if the visibility had not been so poor
- if the weather had set in where there was no bridge
- if the tug master had stopped to wait out the squall
- if the master had kept sight of the bridge
- if the current speed and direction had been different
- if the master had backed down and realigned the tow
- if the tugboat had different maneuvering capabilities
- if the barge had not been loaded.

It is clear that a combination of vessel handling system and environmental conditions converged to set up this accident.¹⁰

¹⁰ "Vessel handling system" refers to the vessel, its propulsion and steering systems, equipment, navigational aids, radar, collision avoidance system, communication systems, other information monitored from the bridge or wheelhouse, towing arrangement and lines, personnel, etc. In summary, the "vessel control system" includes the vessel and everything on it that is used in maneuvering within the larger system which takes in fixed and variable environmental conditions, other traffic, rules, regulations, conventions, and vessel traffic services.

Coast Guard personnel have recognized for some years that vessel accidents tend to be multicausal. Thus, they have advocated a systems perspective in marine safety analysis¹¹ and have sought in the agency's research program to develop ways of defining and analyzing accident factors, and assessing the merits of preventive actions, that recognize the apparently complex nature of vessel control problems.

This study used discrete multivariate analysis to account for interactions of accident factors. In general, "multivariate" describes statistical analyses that treat several variables simultaneously. "Discrete" refers to the nature of the variables (in this case, characteristics of vessel operations) that may be accident factors. Most of these variables are either "on or off," present or absent. They are not measurable on continuous scales of numbers. For example, the radar was operating or not, the hazard to navigation was detected in time or it was not. The mathematics used must be suited to variables measured in discrete categories or ranges (radar on or off, visibility $\frac{1}{4}$ to $\frac{1}{2}$ mile). This requirement rules out a great variety of standard mathematical formulas like those in engineering and physics. Regression analysis, multiple correlation analysis, and analysis of variance, for example, cannot be readily applied.

Because discrete multivariate analysis is a fairly new field (the first major textbook was Bishop, Feinberg, and Holland, 1975), a review was made of various methods that might be suitable for analyzing the data in this study.¹² Some rather sophisticated formulas were found for dealing with

¹¹ J. S. Gardenier, Concepts for Analysis of Massive Spill Accident Risk in Maritime Bulk Liquid Transport. Washington, D.C.: U.S. Coast Guard Office of Research and Development, June 1972. NTIS AD746035. W. D. Snider, The Systems Approach and Tank Vessel Safety. Washington, D.C.: U.S. Coast Guard, Office of Merchant Marine Safety, May 1978.

¹² W. McGill, "Multivariate Information Transmission," Psychometrika, Vol. 19, No. 2, June 1954. W. Garner and W. McGill, "The Relation Between Information and Variance Analyses," Psychometrika, Vol. 21, No. 3, September 1956. Y. Bishop, S. Feinberg and P. Holland, Discrete Multivariate Analysis: Theory and Practice. Cambridge, Massachusetts: The MIT Press, 1975. S. Feinberg, The Analysis of Cross-Classified Categorical Data. Cambridge, Massachusetts: The MIT Press, 1977.

complex relationships of discrete variables, but only in cases where at least one of the following situations exists:

- the processes are fairly well understood to begin with
- the number of variables to be examined is limited to less than about 20 (and preferably to less than 10), and/or
- the data bases contain many thousands of cases.

Our sample had only 419 usable cases for collisions, rammings, and groundings. There were nearly 400 variables of interest for collisions alone. Intuitive judgment about the frequencies and patterns of accident factors is unreliable simply because the accidents are not well understood.

Because of the contrast between the analytic scope and data base size, it was impossible to do an exhaustive, multivariate data analysis in this study. What could be done exhaustively was a two-way (bivariate) "contingency table" analysis of the task performance factors, excluding the situational factors. In addition, interactions of three variables were explored on a limited basis.

A contingency table is a simple calculation of the combinations of values taken by two or more variables in each case being examined. In this analysis there were four possible combinations: both variables are on; variable one is on and variable two is off, or the reverse; or both are off. For example, the radar on a ship's bridge was either on or off just prior to a collision, and the vessel personnel either had a problem in detecting the other vessel or they did not. The contingency table shows how often there was a detection problem when the radar was on as compared to when it was off. It also shows us how often the radar was on or off when there was no problem in detecting the other vessel. The computer program SPSS (Statistical Package for the Social Sciences) was used to create the contingency tables and related statistics.

To evaluate the relationships indicated by the tables, a common test of statistical significance was used, the "Chi square" test, which measures the differences among numbers in the various blocks of the contingency table.

Higher values of the Chi square statistic indicate that the values of the variables tend to exhibit some pattern in relation to each other. The Chi square "significance" level is a measure of the probability of seeing the observed specific differences among numbers in the table if perfect knowledge of the real world (given a sufficiently large sample) would actually show an even distribution (no differences) among the boxes. Thus, a high value (such as .9999) means that it is very reasonable to assume that the two factors are independent of each other. Conversely, a very low value (such as .0001) indicates a very distinct pattern of association; it indicates that these numbers have only one chance in ten thousand of showing up this way if there is no actual association between them in the real world of commercial vessel accidents.

Following a common, conventional practice in social science statistics, we selected a cutoff significance level of less than or equal to 0.05. Thus we say that there is a statistically significant relationship between factors if the chance that we are wrong is less than or equal to five percent.

There is a chance that two factors test out as randomly related until a third factor is introduced. For example, in groundings, there is no significant relationship between failure to establish (or to maintain) position and the complexity of the situation (say, presence of another vessel in the immediate vicinity) until the factor of current is considered. Given the first two problems, if current is misjudged as well, then we have one kind of representative grounding scenario. Without the concurrent failure to handle the current, there is no particular association between situation complexity and failure to establish (or to maintain) position. (See page 4-28.)

It may be that testing still more factors would show that the pattern above only pertains if the channel is narrow and/or if the vessels are large or the watchstanders are unlicensed. There is no way to be sure in advance which four-way, seven-way, or ten-plus-way patterns may be important. Some such complex patterns could exist even though none of the simpler patterns (combinations of two or three variables) had any significance. However, there

is a limit on the number of factors that can be considered simultaneously, depending on the sample size. If the data are divided into too many classifications, the number of times any particular combination could occur is too small to interpret.

Further, it is possible (up to five chances in a hundred) that an apparent pattern in the data does not exist in the real world, but just happened in this sample by chance. (Getting five heads in five flips of a fair coin is unusual, but not all that startling - three chances in a hundred.)

Finally, it is very possible that an almost "perfect" pattern in the data does not reflect the real world. It may reflect instead the way the analysts in this study were instructed to fill out the Casualty Analysis Gauge worksheets or else the way field investigators of marine casualties are instructed to present their findings.

It is important that serious technical readers of this report understand on the one hand that the results of this analysis are carefully derived and frequently strong, but on the other hand, are almost certainly incomplete with regard to the description of any particular relationship or pattern.

Many more statistically significant patterns were found in the analysis than were expected, even exploring only a portion of the two-way and three-way relations among factors described in the appendix. This limited the ability to pursue those findings in more complexity within the scope of this study. It is also apparent that still more sophisticated and powerful analytic tools should be found and brought to bear to explore the data base resulting from this study in order to exploit more fully the data which are now available.

Results of contingency table analysis are presented in Section IV, following the description of the data base content (frequencies of individual variables) in the next section.

III. DESCRIPTION OF THE ACCIDENTS

This section presents the basic data obtained by analysis of accident reports using the Casualty Analysis Gauges (CAGs). A total of 419 cases was studied, including 103 collisions, 154 rammings and 162 groundings. The data are tabulated by accident type.

The same CAG was used for rammings and groundings. A different questionnaire was prepared for collisions, but it has many correspondences with the rammings and groundings questionnaire. Where possible, the findings are compared for collisions, rammings, and groundings. This is not possible only where the scope of the questionnaires does not coincide; for example, the collision questionnaire contains a number of questions pertaining to communications problems between colliding vessels, which are not a part of the ramming/grounding line of questions.

The CAGs are contained in an appendix. They are divided into parts that address vessel characteristics, variable environmental conditions, personnel characteristics, the scenario of operations, navigational aids and task performance, and judgments as to accident-precipitating factors. The CAGs are lengthy, and a sizable number of the questions they contain could not be answered from the reports on many cases. Frequencies are presented here only for questions that could be answered in at least 60 percent of the cases.

PRESENTATION FORMAT

The CAG results are presented in sections that correspond generally to the divisions of questions in the CAGs:

1. Vessel Description: This section presents the responses to questions concerning a number of vessel characteristics such as vessel type, gross tonnage, length, number of assisting vessels, manner of towing and others. In addition to a breakdown by accident type, this section splits up appropriate variables by vessel type (ship or barge/tow/tugboat configuration).
2. Environmental Conditions: This section addresses variable environmental conditions encountered at the time of the accident. The variables considered are visibility, wind speed, sea swell, and time of day.
3. Personnel Information: This short section provides information about operator's licensure and his time in charge preceding the accident.
4. Other Questions: This section includes questions pertaining to the scenario of vessel operations and navigational aids and task performance. The response rate on these topics, along with the personnel characteristics topic, was low. There are questions on bridges, canals, radar, and whether the accident took place in a turn.
5. Inferences about Task Performance Factors: This is the longest and most significant section presented. It offers the raw data on the interpretive sections of the questionnaires in which an attempt was made to assess the impact of particular activities and situational factors in each accident. A complete set of responses was obtained in the section.

The CAG questions were designed to be answered yes or no to establish the presence or absence of various conditions that may contribute to the likelihood of an accident. "No data" and "not applicable" codes were provided where appropriate. The results are presented in bar charts showing the number and percentage of yes answers over some base number. The base numbers change, depending on the number of no data and not applicable responses. When the "no data" response is substantial, the base number is stated.

The collision results require special treatment because more than one vessel was actively involved in the accident. Vessel characteristics are

presented for all vessels that fit within the population definition of the study--i.e., ships of more than 10,000 GRT and tug/towboat-barge configurations. The total number of such vessels in the 103 collision cases studied is 130. For the smaller vessels involved, only the vessel type is presented (e.g., fishing vessel, recreational boat, etc.).

VESSEL DESCRIPTION

(Note: "Ship" means ship greater than 10,000 GRT and "barge" means tug/towboat-barge configuration unless otherwise stated.)

Barges typically outnumber ships in harbor areas, and this is reflected in the population of accidents in harbor areas (at least ramming and grounding accidents), as was shown in Section II (Tables 2.2 and 2.3). In the study sample, however, there is a roughly even split between ship and barge involvement in the collision and ramming cases, and a preponderance of ships in the groundings. These findings are shown in Chart 3.1. The most obvious explanations for the grounding results are the differences in draft and hull form. Ships are more susceptible to grounding and less likely to get off without assistance and without some damage. Ship docking/berthing procedures may also create greater opportunity overall for ramming resulting in significant damage.

Tank and general cargo vessels, both ship and barge, are fairly equally represented in the sample of all three types of accidents (Charts 3.2-3.4), groundings involved tankships more often than general cargo ships, although the difference is less than 10%. If this difference represents a tendency, it is possibly attributable to differences in draft. Tankships were less often involved in collisions than were general cargo ships, a difference of 12%.

Chart 3.2 includes all vessels within the study population definition that were involved in the study sample of collisions. Chart 3.5 shows the combinations of vessels in collisions, including cargo-carrying ships of less than 10,000 GRT, construction vessels, and other craft. Just about half of the collision cases involved one of these smaller vessels. The predominant types were:

- Small general cargo ships (in 18 percent of the cases)
- Fishing vessels (in 13 percent of the cases)
- Recreational vessels (in 9 percent of the cases).

Ship Characteristics

As shown in Charts 3.6-3.8, the ships were typically:

- 500-700 feet in length
- in excess of 15,000 GRT
- loaded.

These characteristics generally hold for all accident types. The proportion of loaded ships is somewhat larger in the grounding cases. Also, the ships involved in groundings and rammings tended to be somewhat larger than those in collisions.

Substantial differences in other ship characteristics are shown for the three accident types:

- More than 70% of the ships involved in rammings were assisted. Only two ships (3 percent) involved in collisions were assisted (Chart 3.9).
- About half of the ships involved in collisions were diesel powered, versus about a quarter of those in groundings and rammings (Chart 3.10).
- Nearly 70% of the ships involved in collisions were foreign registered, versus roughly 45 percent of those in groundings and rammings (Chart 3.11).

The differences in assisting vessels involved in each accident type (Chart 3.9) reflects the type of activity for which assisting vessels are employed. Ships are most often assisted during docking and undocking as well as in the short periods of time preceding and following during which slow and intricate maneuvers may be necessary to position in limited space. These activities create opportunities for ramming. Thus, it is found that 73% of rammings occurred while assisted. Collisions involving assisted ships are rare in the study sample (3%). This may be related to the absolute time a ship spends assisted compared to the amount of time a collision might occur. Also, with the slower speed and extra caution, as well as the extra eyes and ears being used while assisted, the chances for collisions are further reduced. The groundings of assisted ships represent areas where docking or mooring facilities are in shallow waters or where characteristics of the approach/departure lanes may require use of tugs.

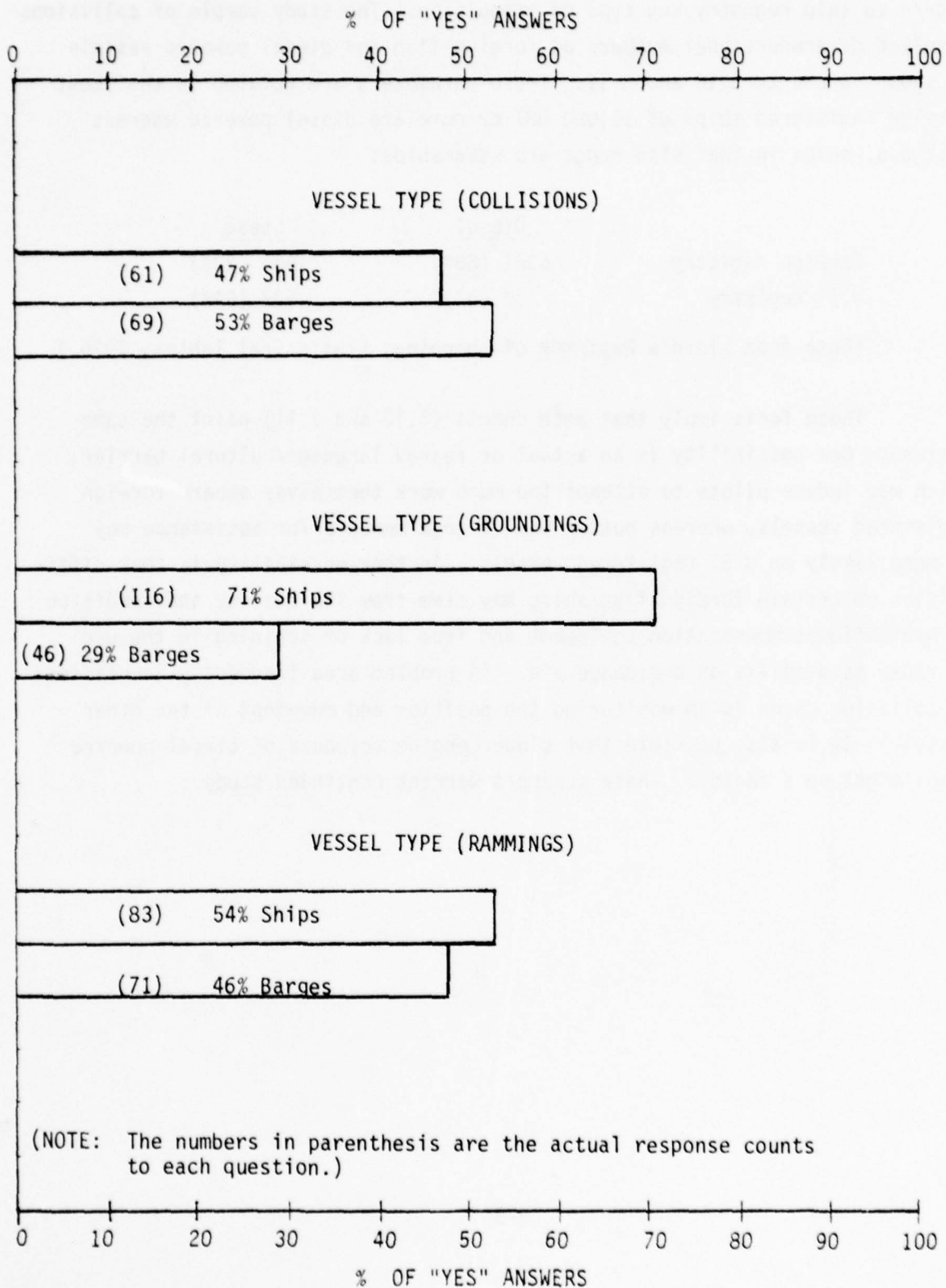
There is also a marked difference between the accident types with regard to ship registry and type of propulsion. The study sample of collisions involved disproportional numbers of foreign flag and diesel powered vessels as shown in Charts 3.10 and 3.11. These parameters are related in that most foreign registered ships of 10,000 GRT or more are diesel powered whereas most U.S. ships in that size range are steamships:

	<u>Diesel</u>	<u>Steam</u>
Foreign registry	6361 (80%)	1635 (20%)
U.S. registry	32 (6%)	537 (94%)

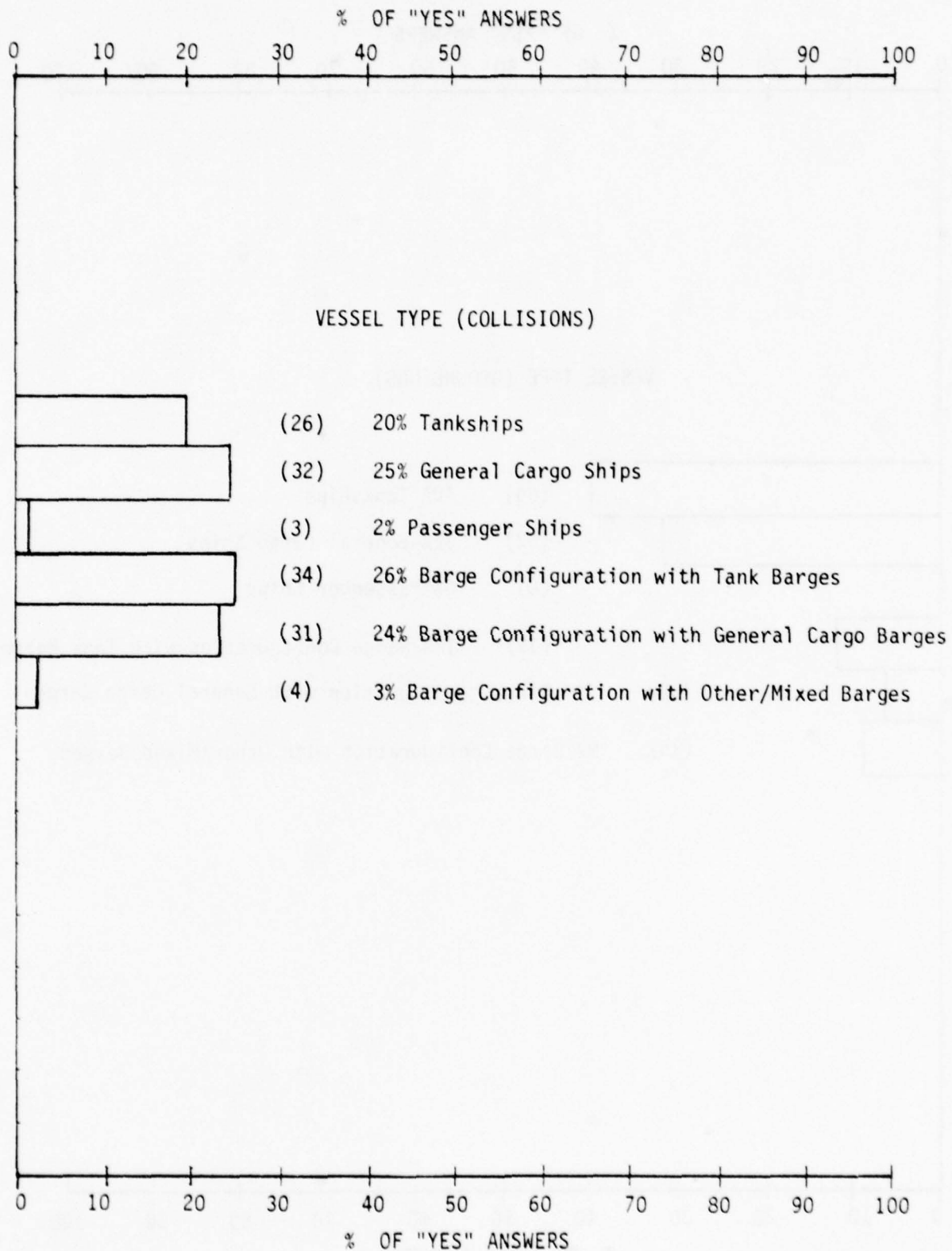
(Data from Lloyd's Register of Shipping, Statistical Tables, 1976.)

These facts imply that both charts (3.10 and 3.11) paint the same picture. One possibility is an actual or feared language/cultural barrier, which may induce pilots to attempt too much work themselves aboard foreign registered vessels, whereas better use of crew members for assistance may be more likely on U.S. registered vessels. Another possibility is that difficulties on certain foreign flag ships may stem from the quality and condition of navigation/communication equipment and from lack of training in the use of radar as a collision avoidance aid. (A problem area frequently identified in collision cases is in monitoring the position and movement of the other vessel.) It is also possible that slower engine response of diesel powered ships might be a factor. These subjects warrant continued study.

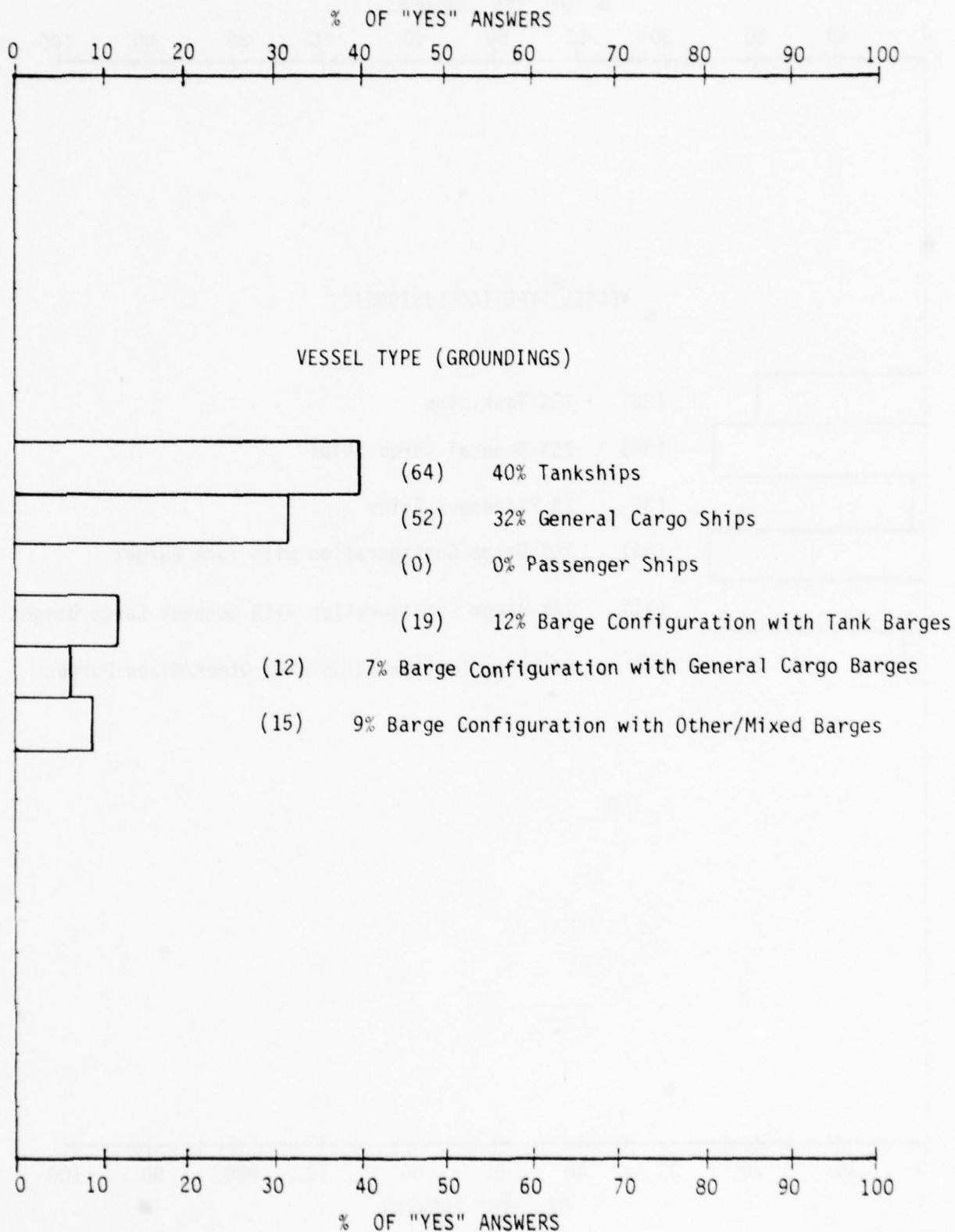
VESSEL DESCRIPTION - CHART 3.1



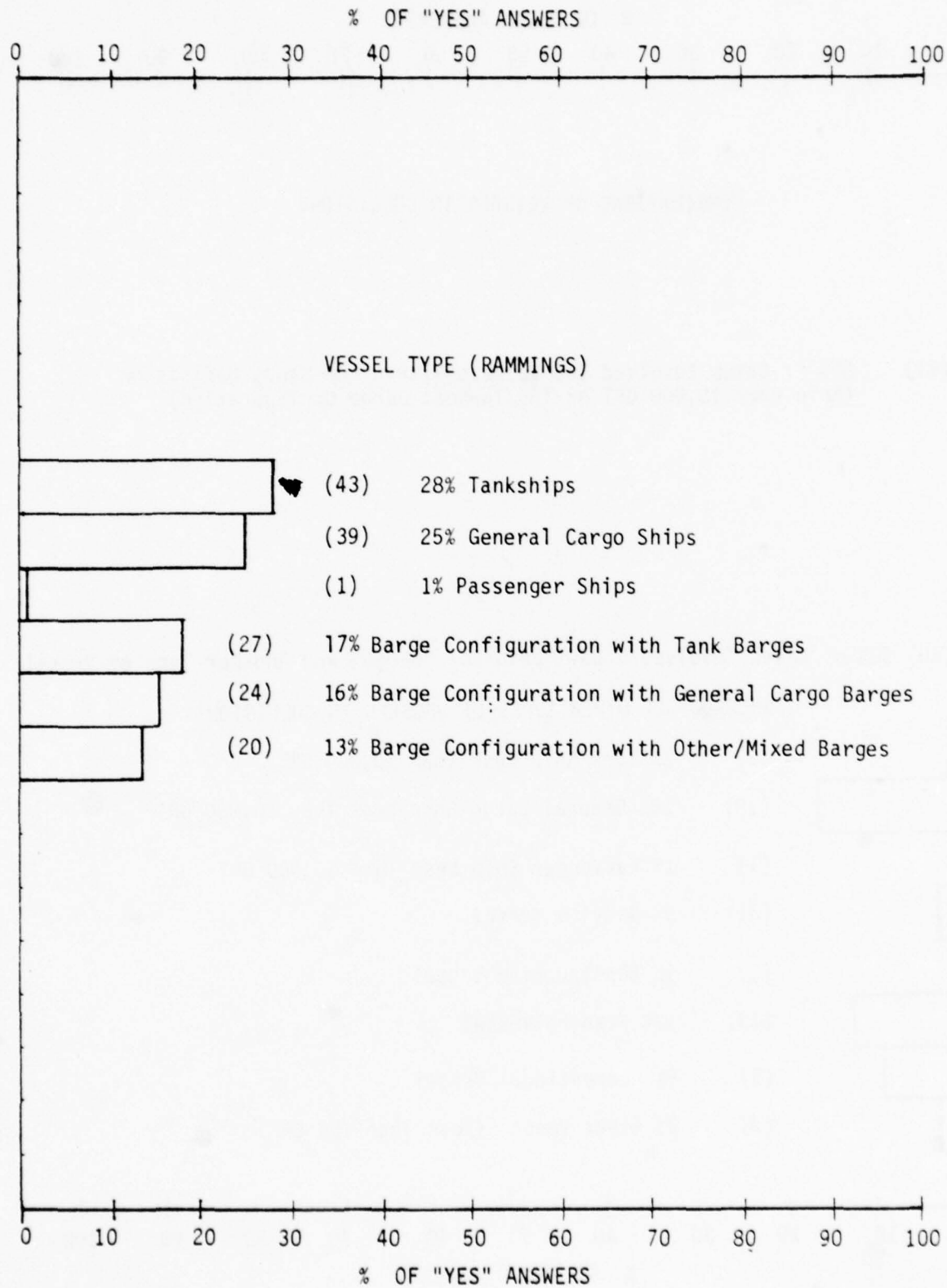
VESSEL DESCRIPTION - CHART 3.2



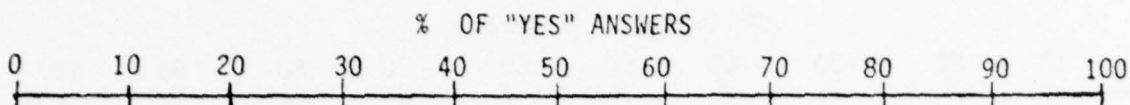
VESSEL DESCRIPTION - CHART 3.3



VESSEL DESCRIPTION - CHART 3.4



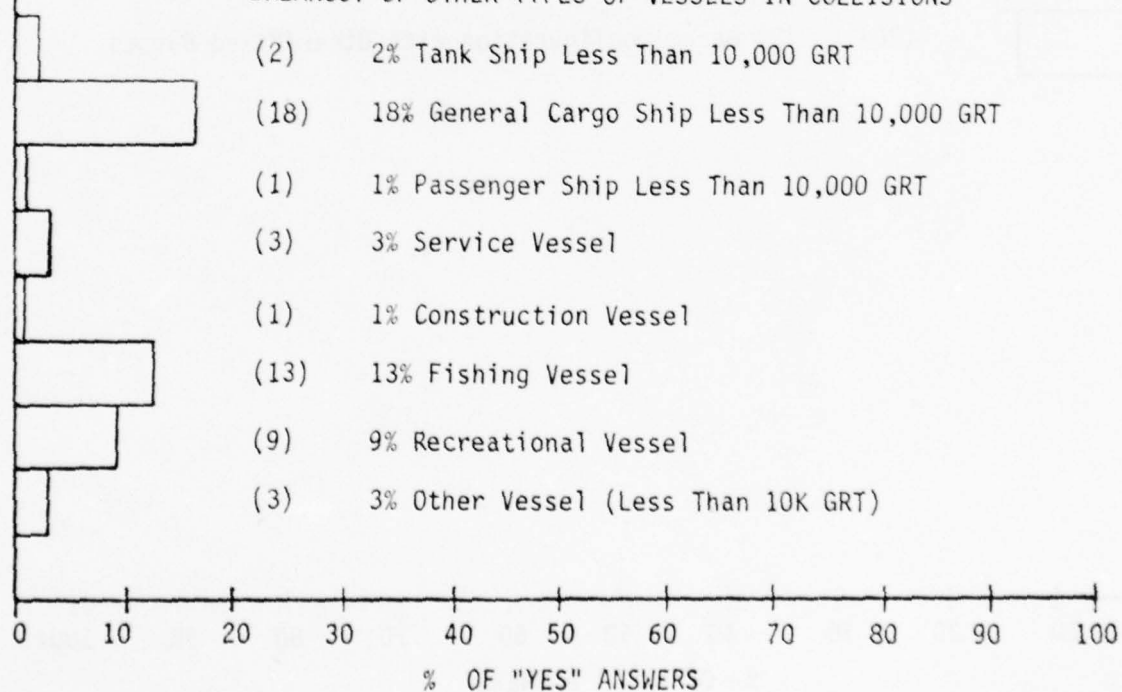
VESSEL DESCRIPTION - CHART 3.5



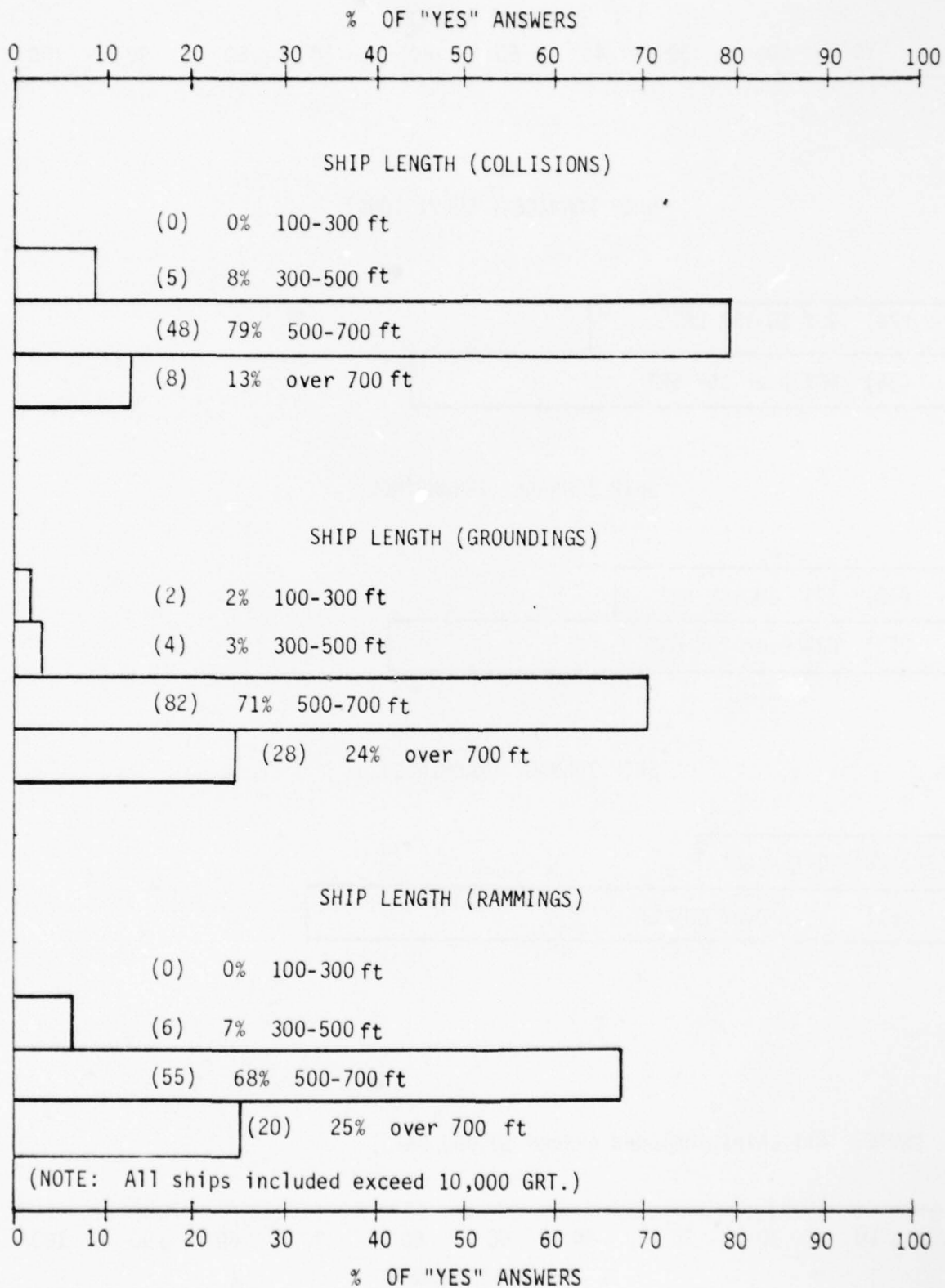
(51) 50% of Cases Involved Two Vessels Within the Study Definition (Ship Over 10,000 GRT or Tug/Towboat-Barge Configuration)

(50) 50% of Cases Involved Study "Ship" or "Barge" and Another Type of Vessel

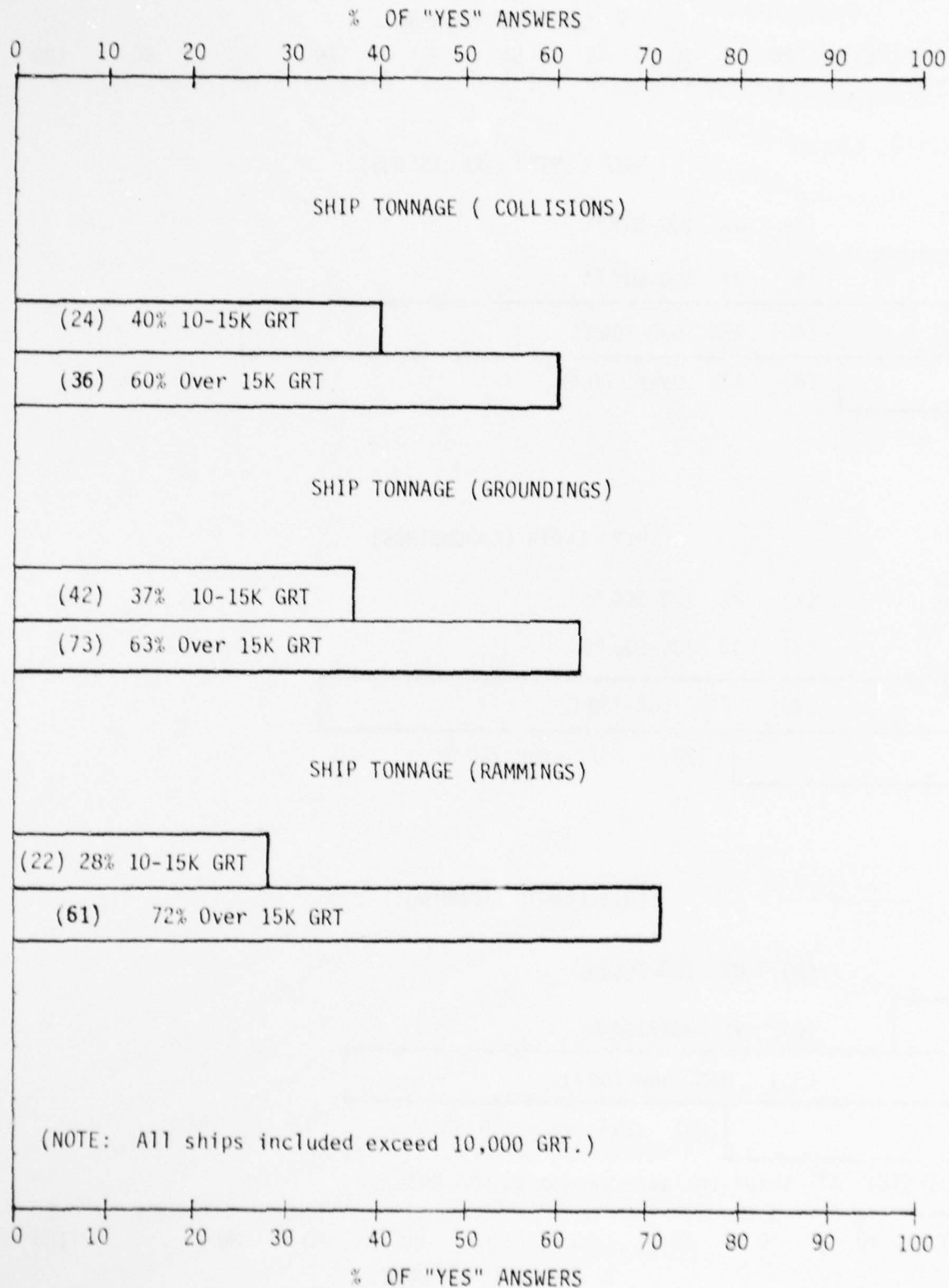
BREAKOUT OF OTHER TYPES OF VESSELS IN COLLISIONS



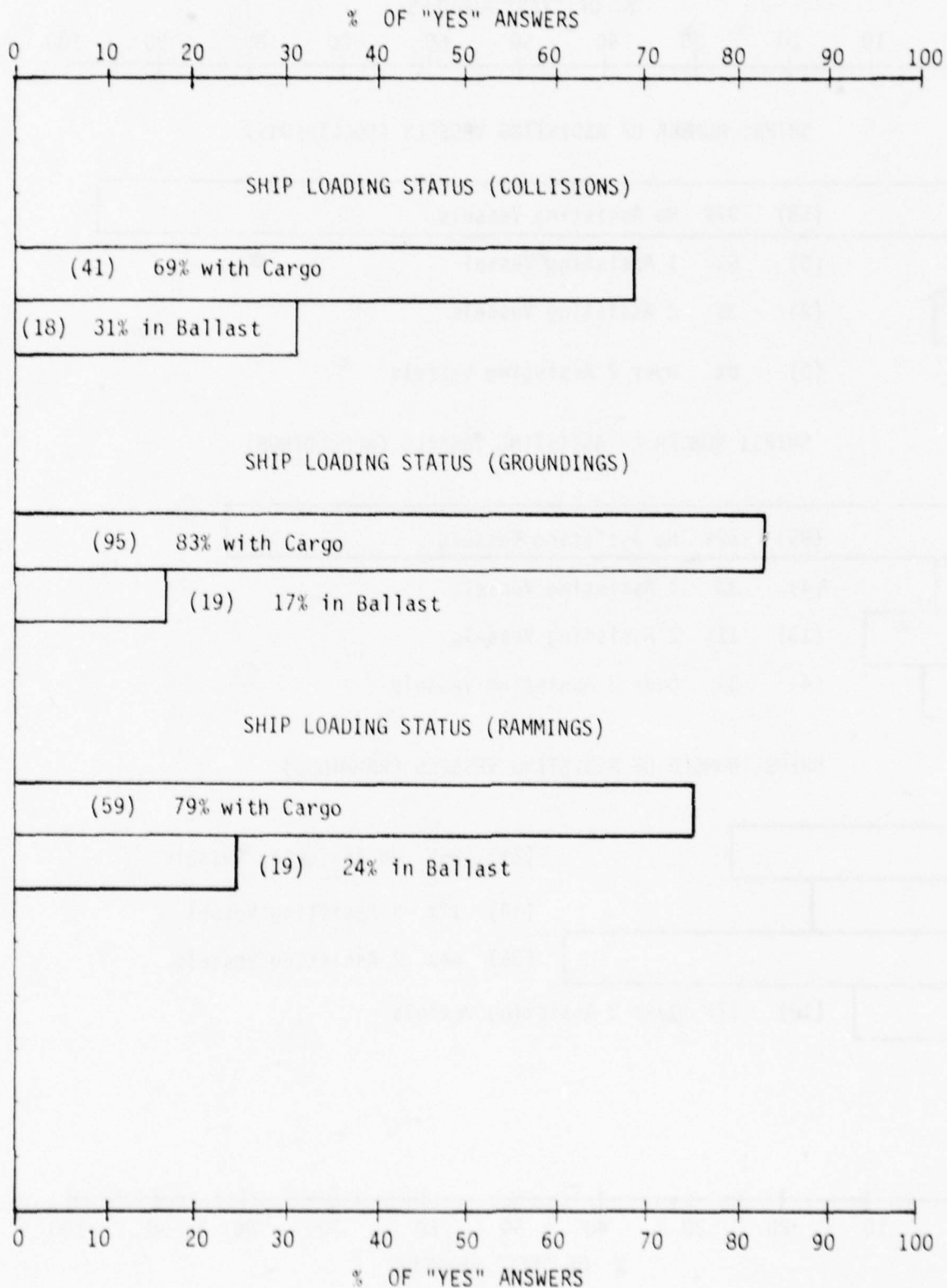
VESSEL DESCRIPTION - CHART 3.6



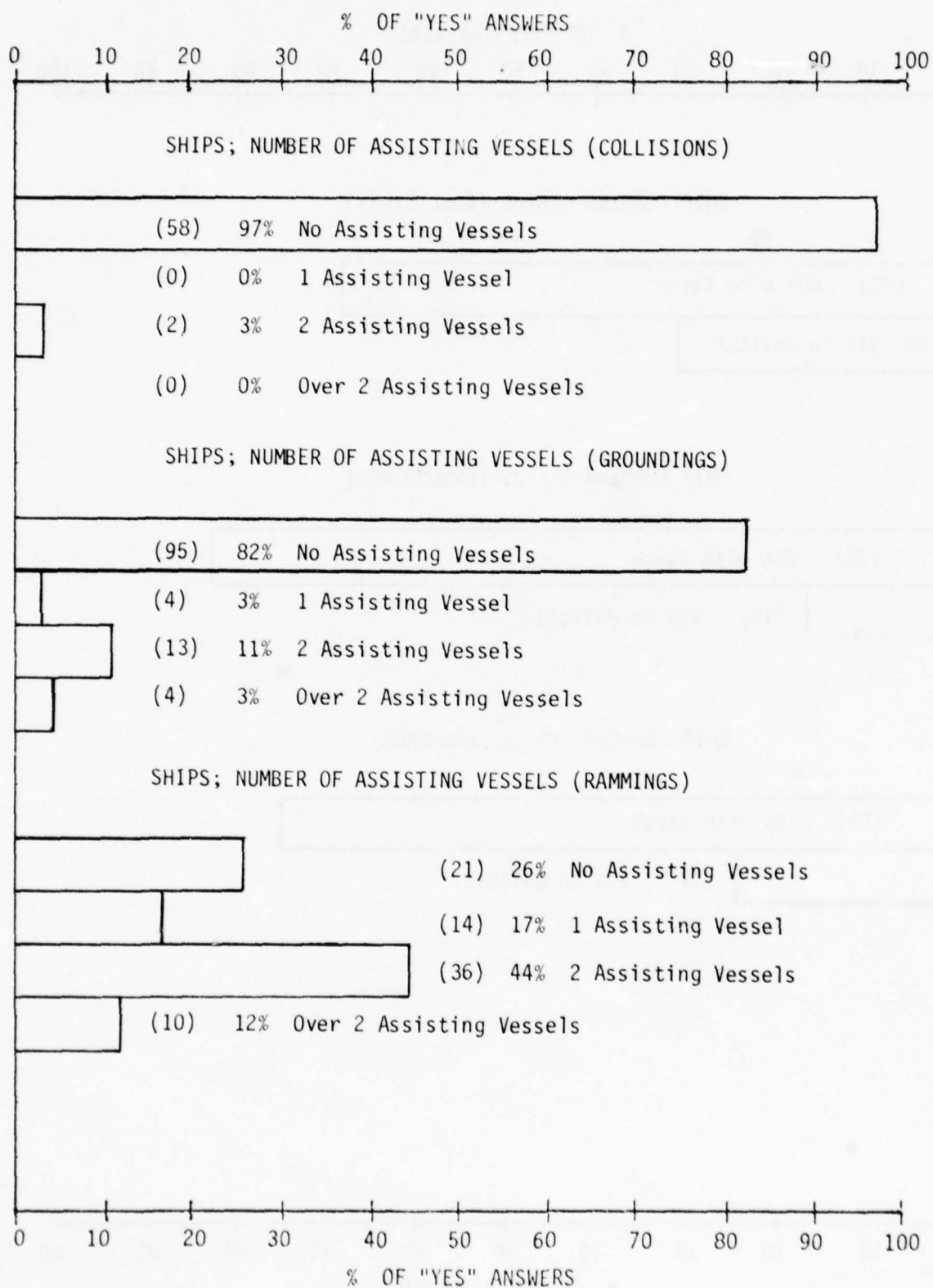
VESSEL DESCRIPTION - CHART 3.7



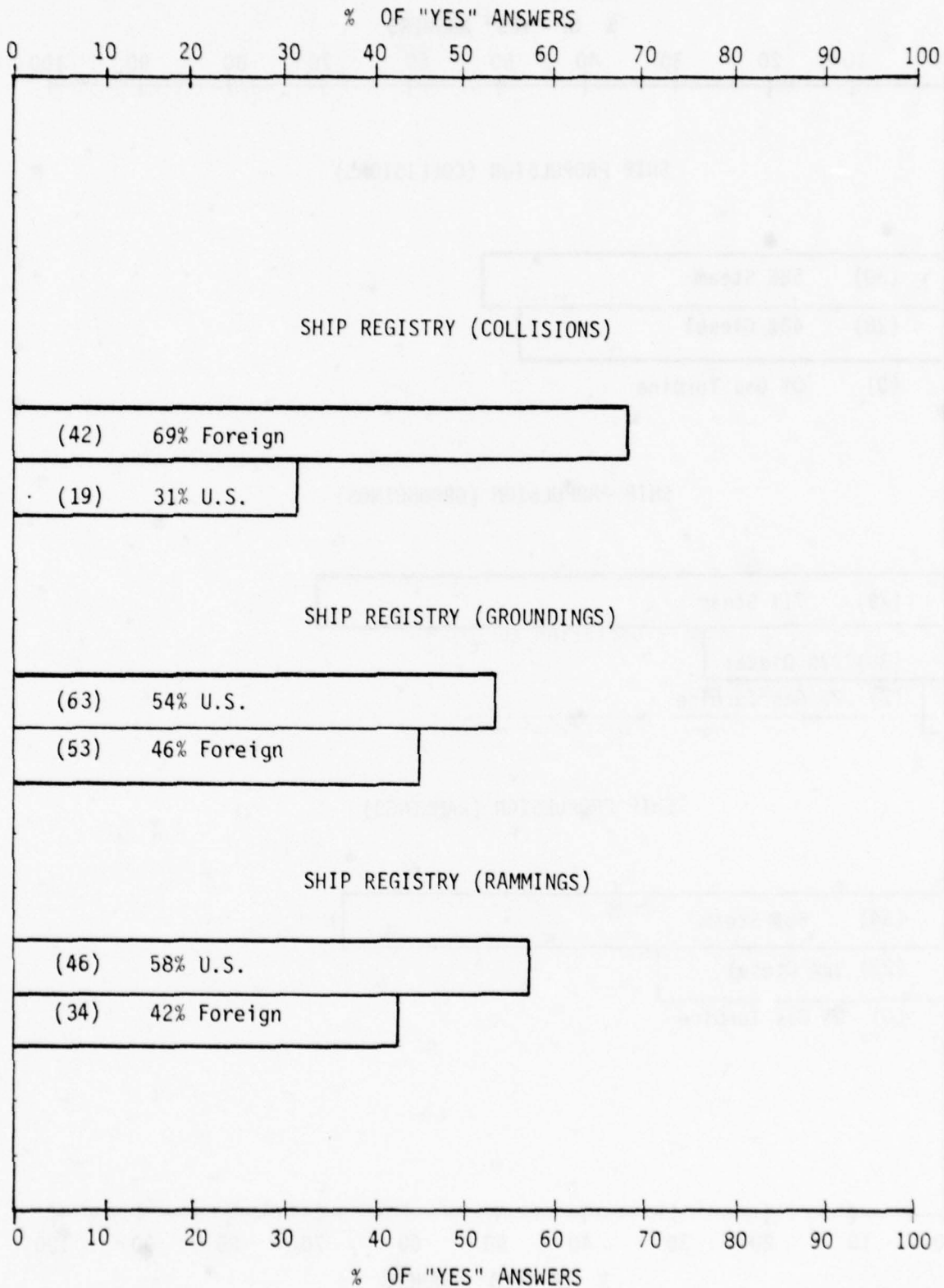
VESSEL DESCRIPTION - CHART 3.8



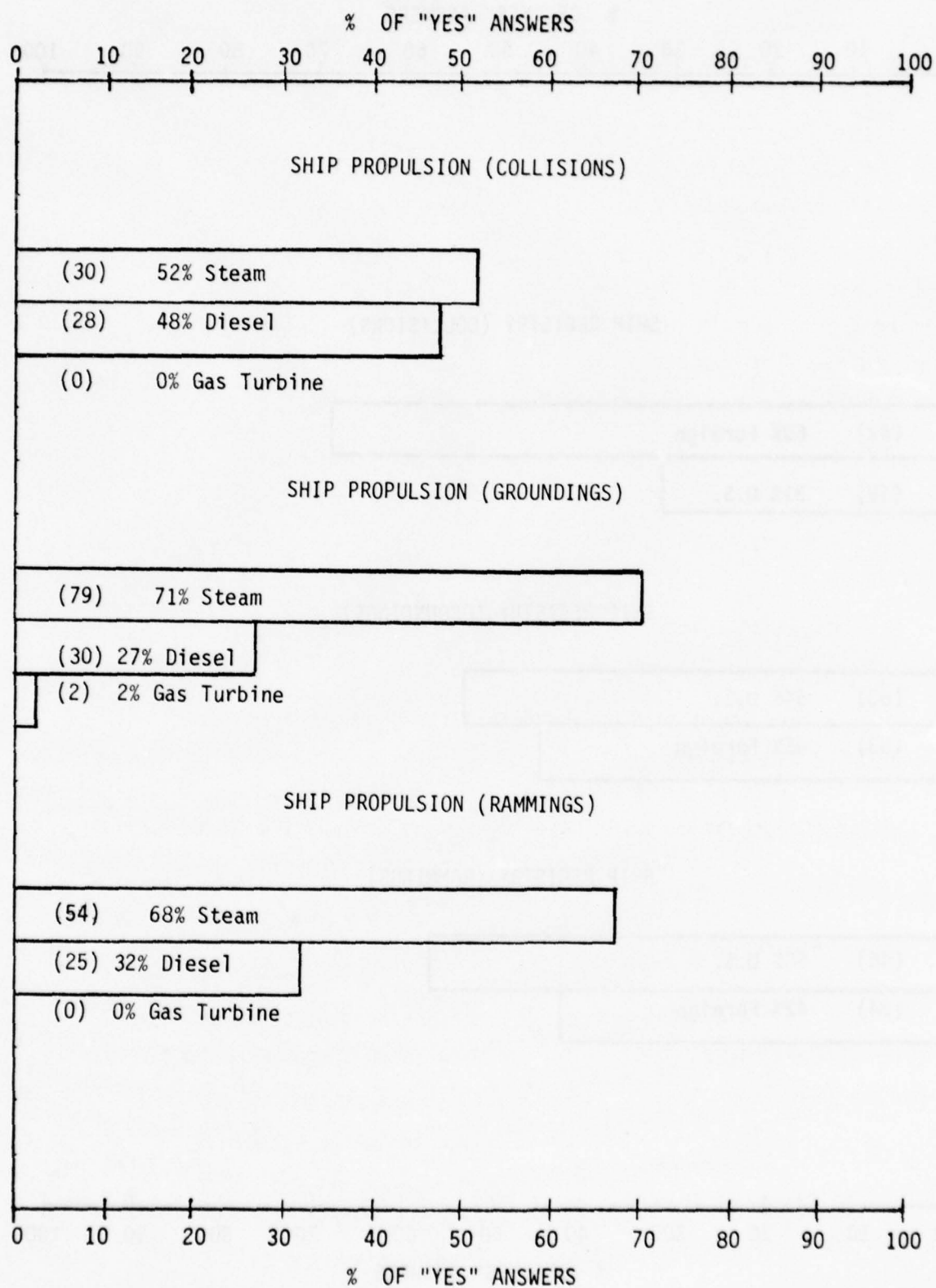
VESSEL DESCRIPTION - CHART 3.9



VESSEL DESCRIPTION - CHART 3.10



VESSEL DESCRIPTION - CHART 3.11



Barge Characteristics

As shown in Charts 3.12 - 3.17, the tug/towboat-barge configurations in the accidents studies typically consisted of a single towing vessel pushing a single, loaded barge. These characteristics hold in a majority of the cases of all three accident types. However, in the rammings cases, more than one towing vessel and more than one barge were involved, notably more often than in the collision and grounding cases.

Chart 3.18 shows that the barge configurations in the rammings tend to be longer than those in the collisions, which is consistent with the larger percentage of rammings involving more than one barge. Yet the barge arrays in the groundings cases tend to be longer than those in both rammings and collisions:

	<u>Collisions</u>	<u>Groundings</u>	<u>Rammings</u>
Total barge length over 300 ft	33%	64%	56%

These results are clarified by comparison with Charts 3.15 and 3.16, summarized below:

More than 1 barge in array	30%	24%	43%
More than 1 barge across	10%	2%	17%

The barge arrays (more than one barge) in the groundings are nearly always strung out a single barge across, whereas those in the collisions and rammings are more likely to be arranged two or more across. Also, in a larger percentage of the groundings, the barge or barges were pulled on hawsers--nearly 40 percent compared to about 25 percent for both rammings and collisions (Chart 3.13).

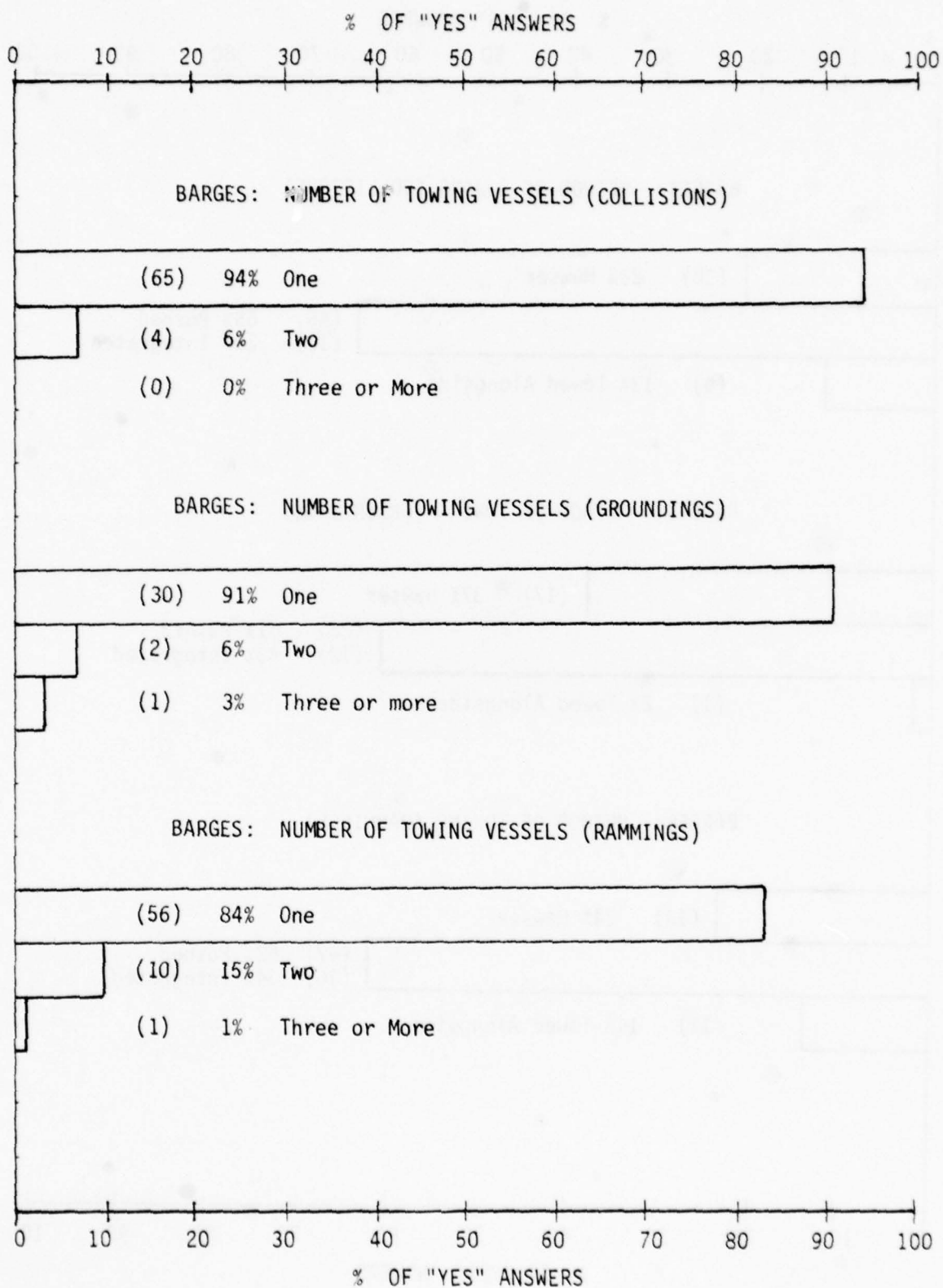
These results suggest different situations in which the three types of accidents are likely to occur. Array width, for example, is a more important factor in maneuvering in a highly restricted situation, as in a fleeting area, or in negotiating a bridge or in passing another vessel in a narrow channel. Groundings and rammings, especially the former, are often attributed to problems of control in the presence of adverse environmental forces, especially current and wind, whereas these factors are rarely cited in

collisions. Longer barge arrays would appear to be more subject to current and wind effects.

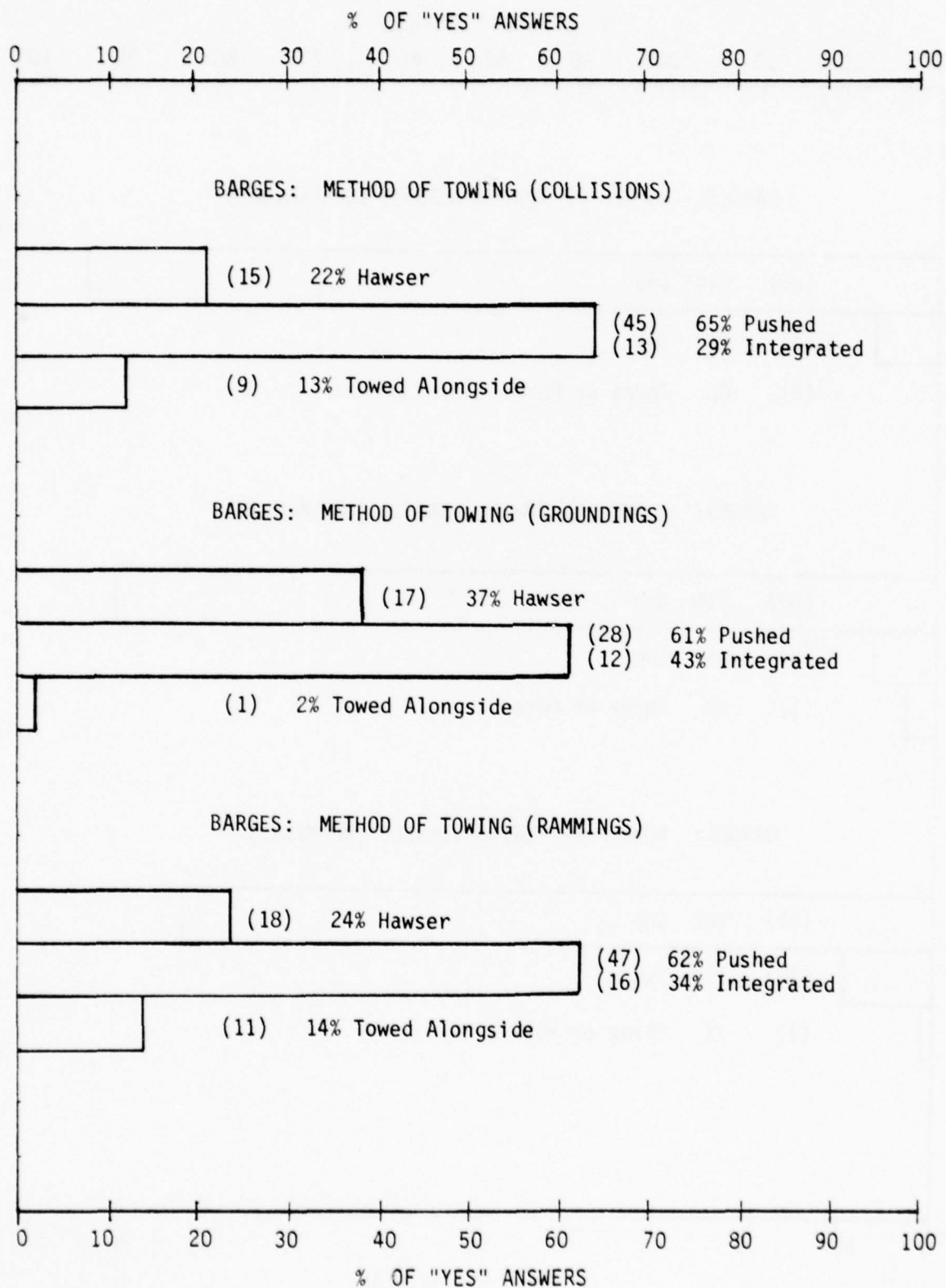
In Chart 3.17, in which the loading characteristic of the barges is presented, the percentage of empty barge arrays in the ramming cases stands out. The percentage of empty or partially empty barges in collision cases is also appreciably greater than in grounding cases.

Barge depth is typically about 10-12 feet. The draft of an empty barge is about 2 feet, with 8 feet of freeboard above the water. It is evident that fully loaded barges are more likely to be involved in groundings than partially loaded or empty (light) barges. The freeboard of a light barge or array makes it much harder to maneuver or control in collision avoidance and in congested areas, and makes it much more susceptible to wind effects. Thus light barges/arrays are more prevalent in ramming and collisions. Also, the minimal draft of a light barge/array effectively increases channel width, so that there may be a tendency to be more expansive or relaxed about maneuvering area. This could lead to problems when another vessel or some other obstacle is encountered.

VESSEL DESCRIPTION - CHART 3.12



VESSEL DESCRIPTION - CHART 3.13

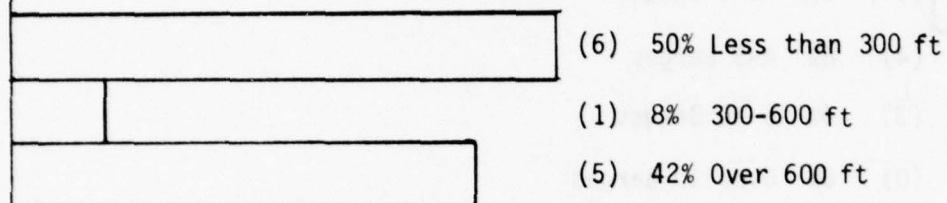


VESSEL DESCRIPTION - CHART 3.14

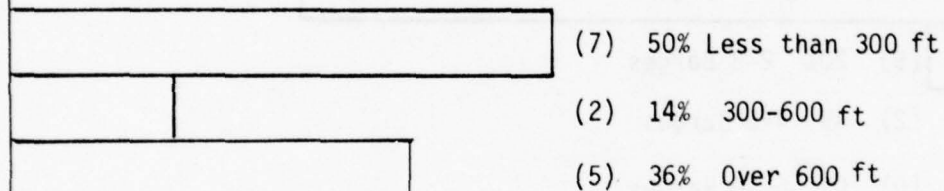
% OF "YES" ANSWERS

0 10 20 30 40 50 60 70 80 90 100

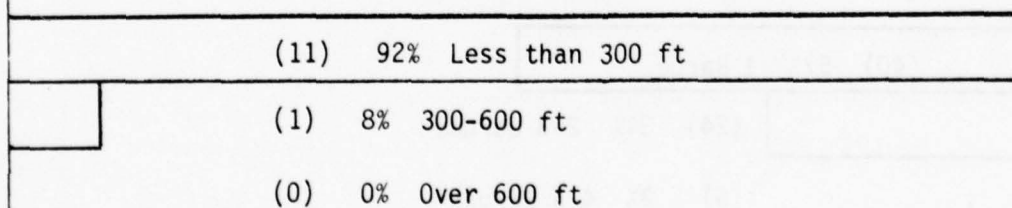
BARGES: HAWSER LENGTH (COLLISIONS)



BARGES: HAWSER LENGTH (GROUNDINGS)



BARGES: HAWSER LENGTH (RAMMINGS)

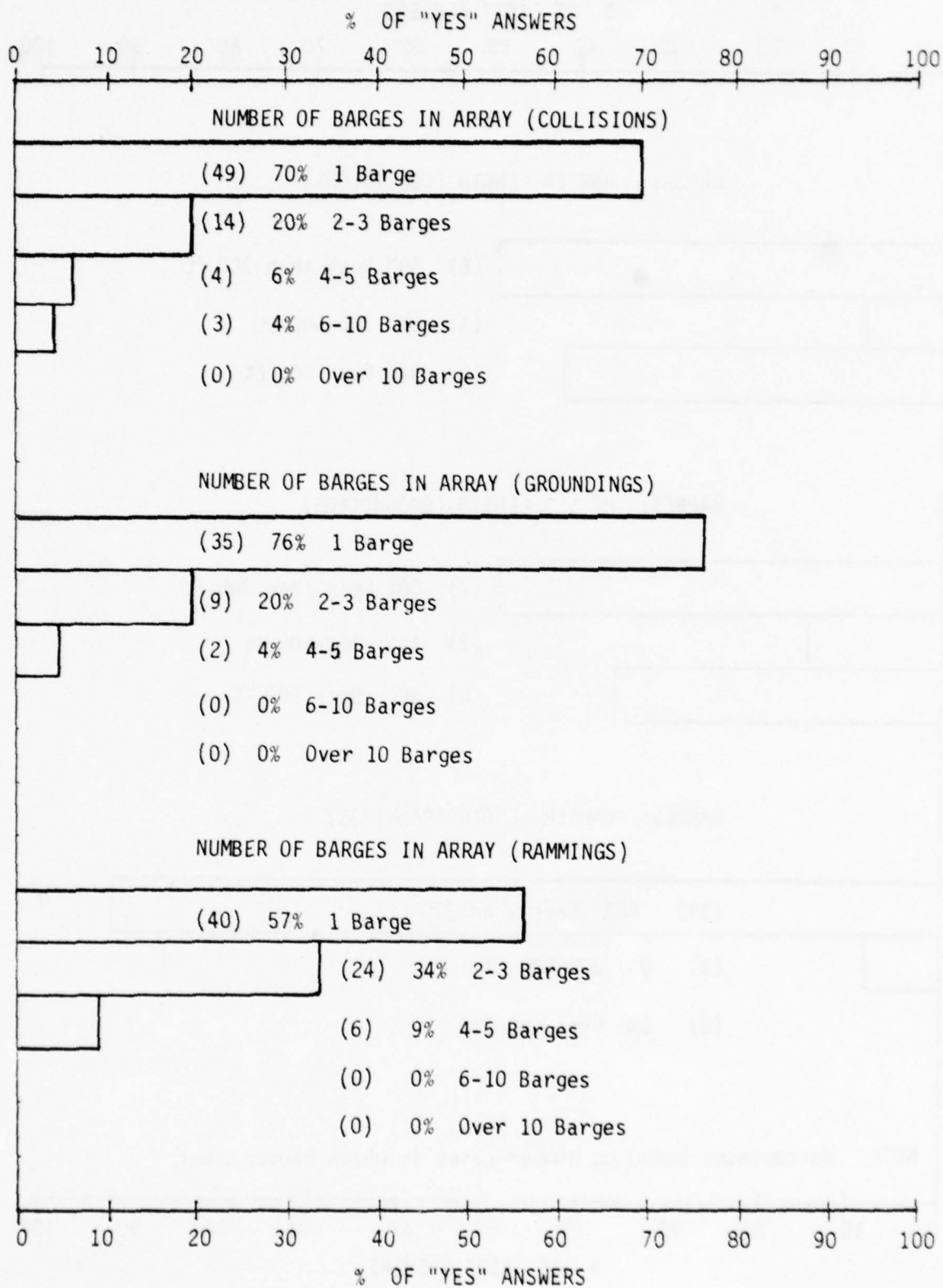


NOTE: Percentages based on number cases in which hawser used.

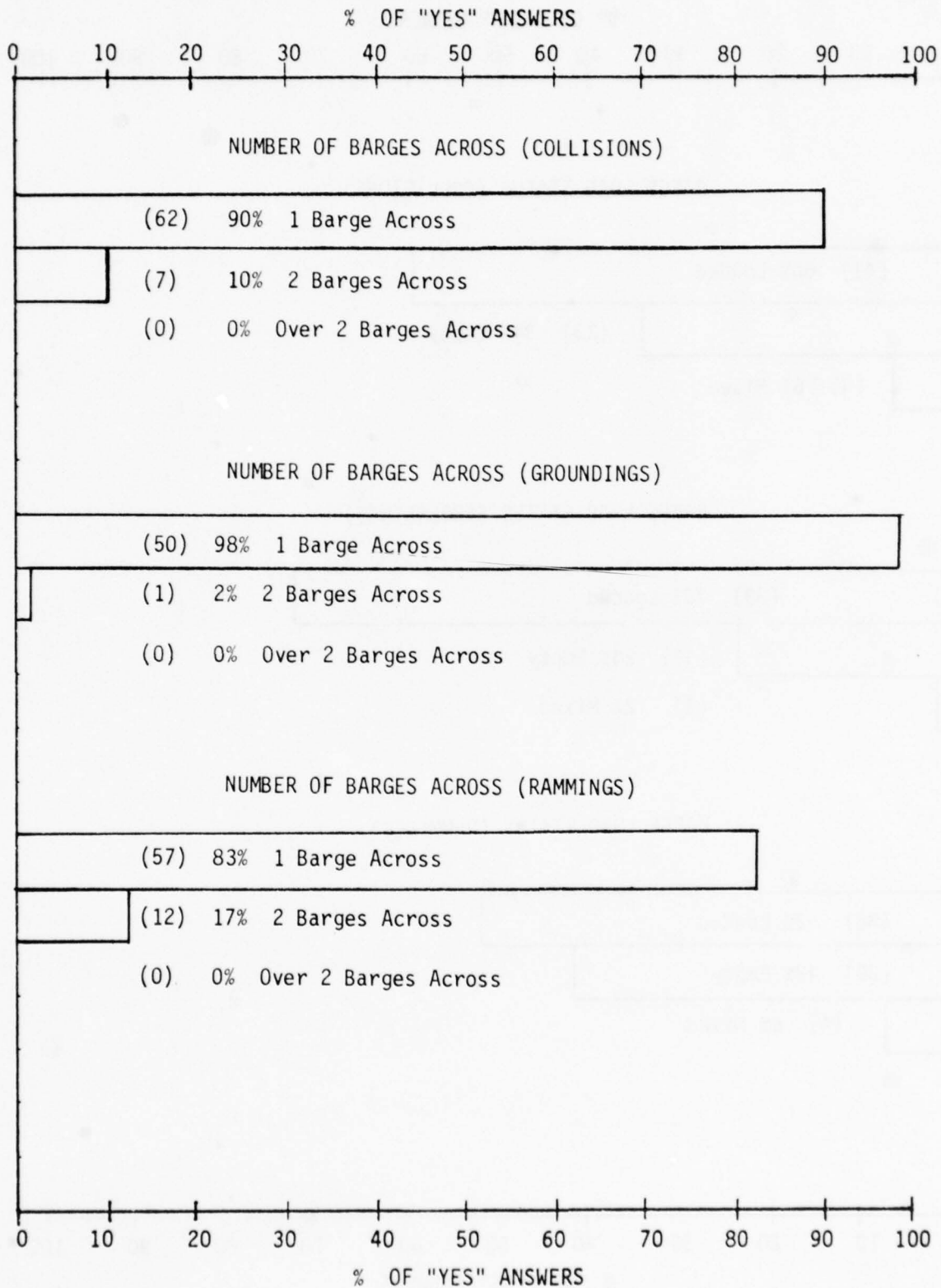
0 10 20 30 40 50 60 70 80 90 100

% OF "YES" ANSWERS

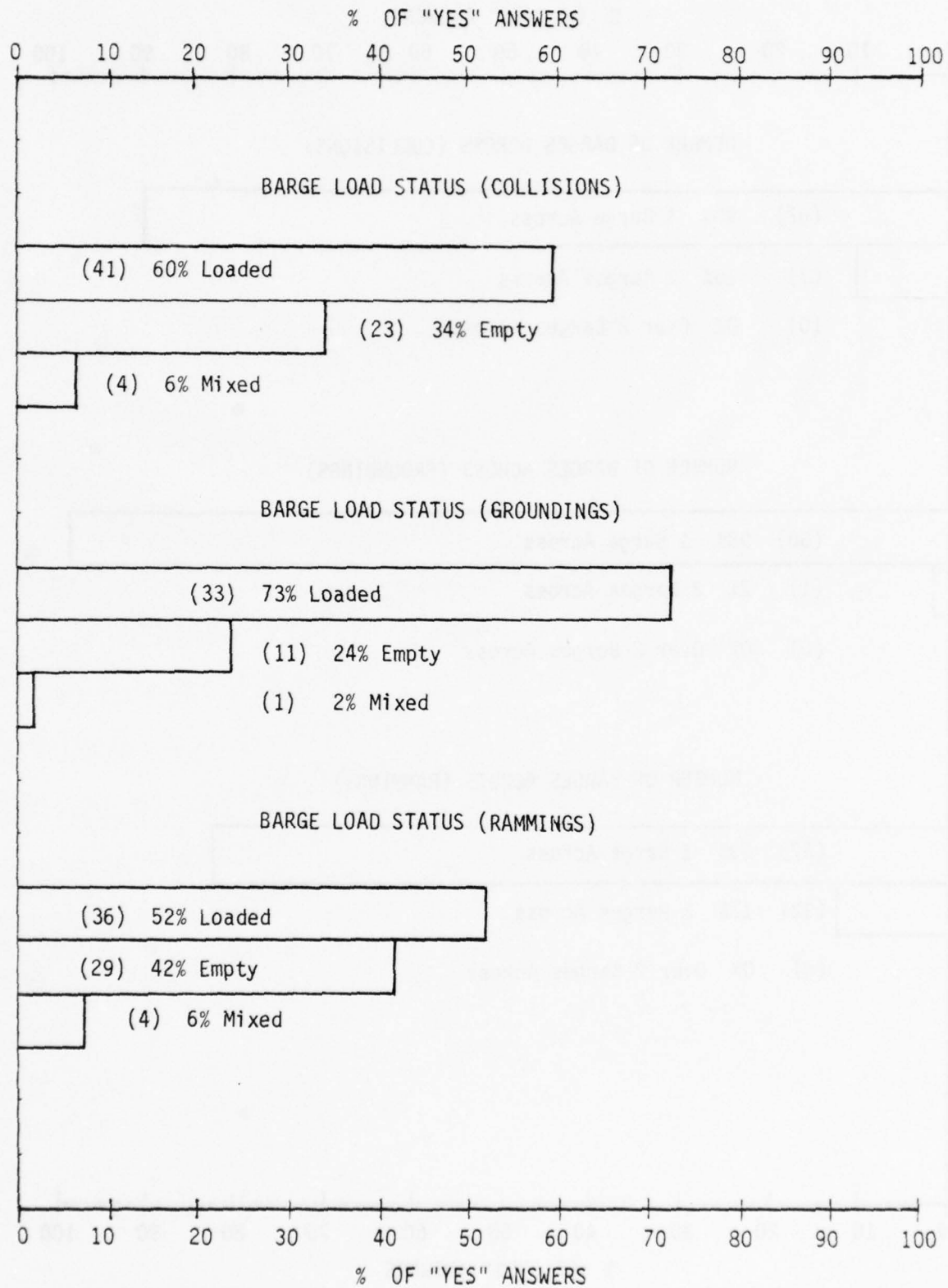
VESSEL DESCRIPTION - CHART 3.15



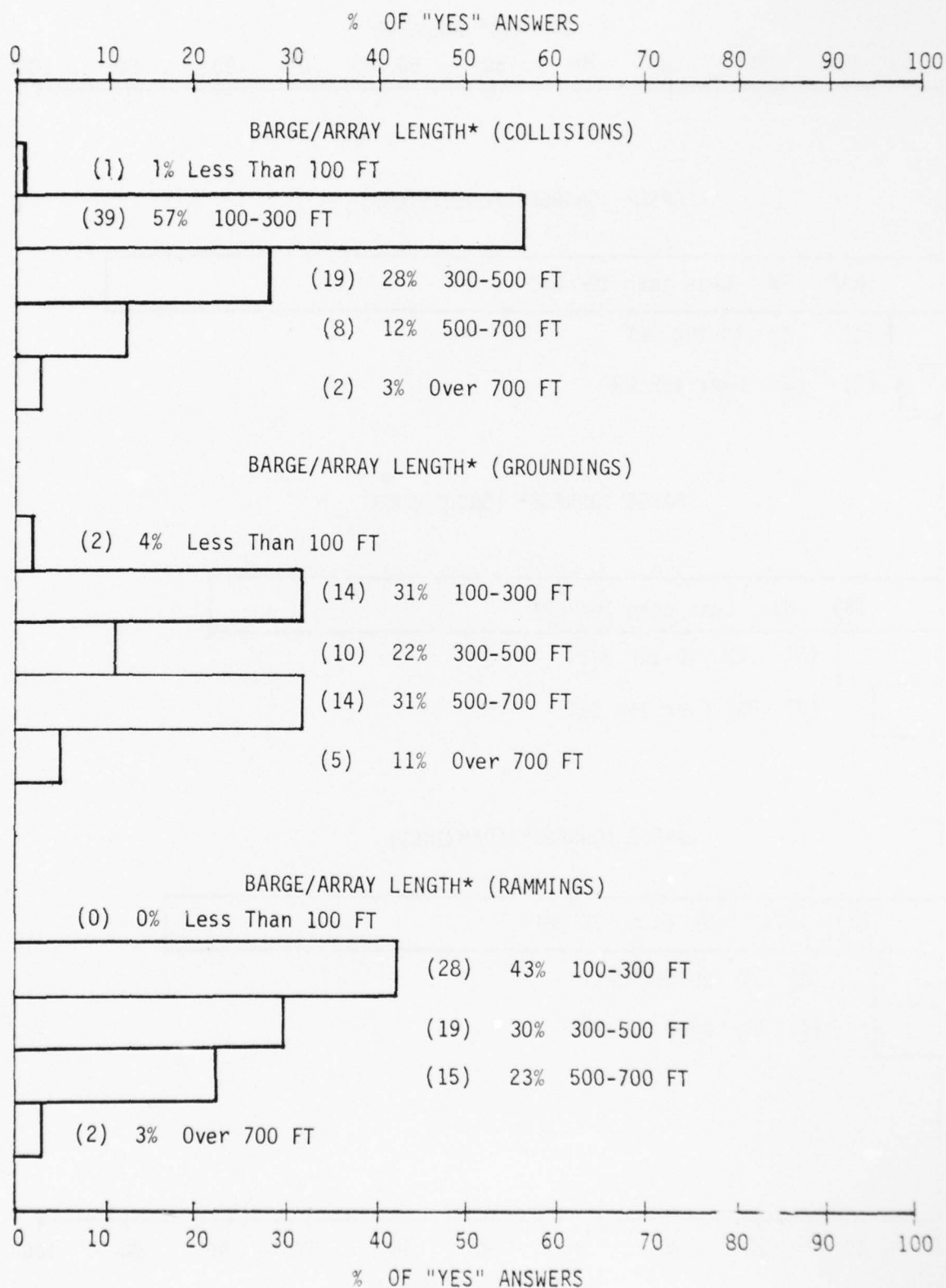
VESSEL DESCRIPTION - CHART 3.16



VESSEL DESCRIPTION - CHART 3.17

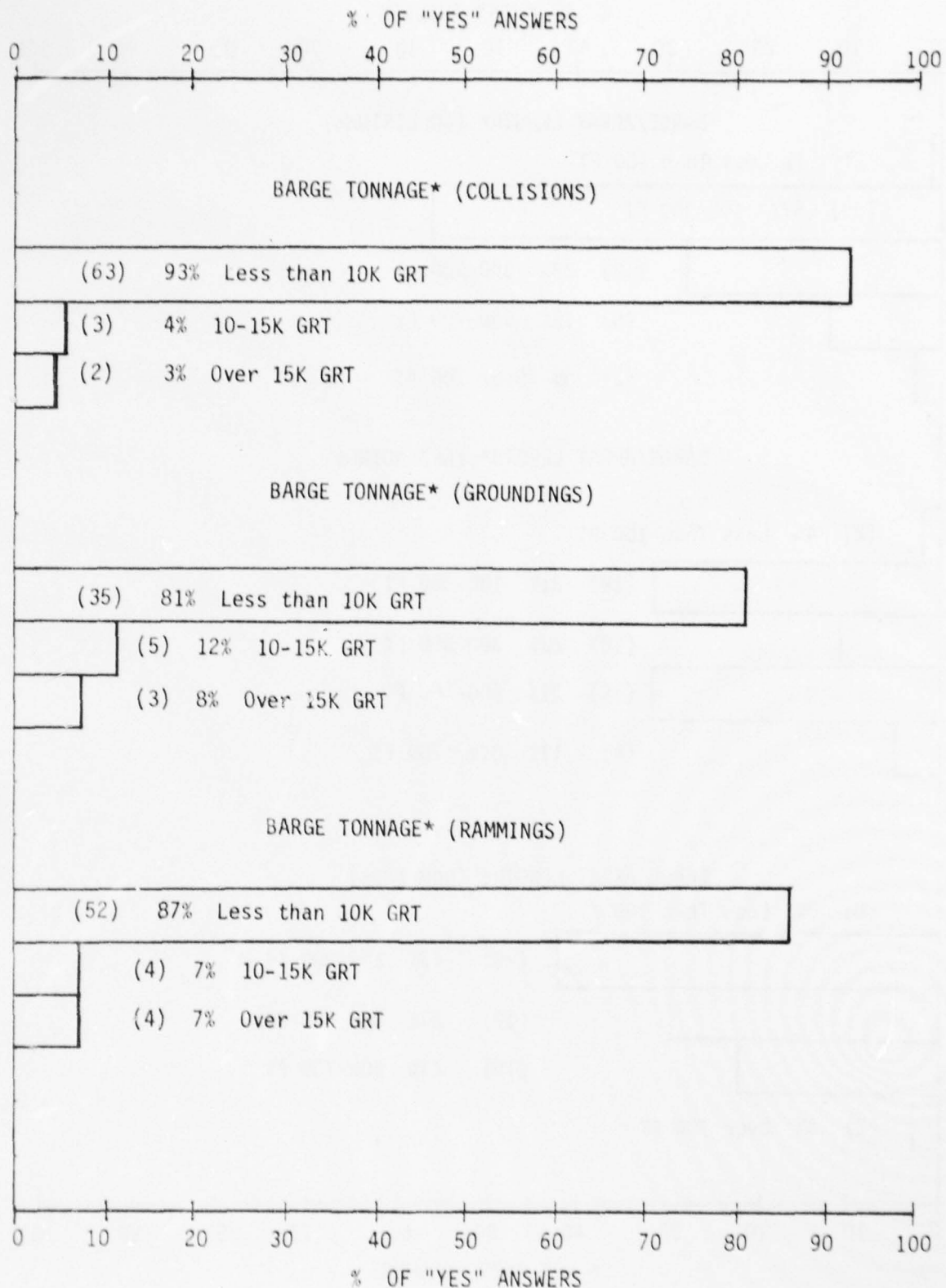


VESSEL DESCRIPTION - CHART 3.18



* Excludes towing vessel and hawser length.

VESSEL DESCRIPTION - CHART 3.19



* Total configuration, including towing vessel(s).

ENVIRONMENTAL CONDITIONS

Charts 3.20 - 3.25 describe environmental conditions present at the time of the accidents studied. They demonstrate that

- 27 percent of all collisions studied took place when the visibility was less than a quarter of a mile.
- 33 percent of all accidents studied took place when the wind speed exceeded 10 knots.
- Sea swells over 4 feet were found most frequently among grounding cases.
- Collisions more commonly occurred at night (56 percent) than during the day (36 percent).

Data on other variables, such as wind direction and current direction and speed, were sought in the analysis of the accident reports (see the Casualty Analysis Gauges in the appendix). Though these variables are believed to be important, they cannot be addressed because of an inadequate number of responses.

The chart on visibility (Chart 3.20) shows clusters of cases at each end of the visibility spectrum (for all accident types). This is artificial because the intermediate answers ($\frac{1}{4}$ to 2 miles) demanded more precision than was usually available in the accident reports. Chart 3.20 basically documents the relative percentages of cases where visibility was low or nil and where visibility was good enough that it would not be considered a factor in the accident.

Extremely poor visibility (less than a quarter mile) is most prevalent in collisions (27 percent). The study scope does not include collection of data on the annual incidence of visibility states in harbor areas. However, the occurrence of 27 percent of collisions when visibility was less than a quarter mile indicates that this condition imposes higher than normal collision risk. The analysis of task performance failures (at the end of this section and in Section IV) points to problems in detection and in monitoring the movement of the other vessel, which are intensified by poor visibility and the requirement to use radar for collision avoidance.

Extremely poor visibility is less frequent (13 percent) in both the ramming and grounding cases. This difference most likely has to do with nature of the hazards. Control-related problems are most prevalent in both groundings and rammings, in conjunction with insufficient information about winds and currents, which are more or less constant problems, regardless of visibility. Pilots are well acquainted with the fixed physical characteristics of the harbor areas in which they work, such as shallow water areas and structures. Thus, poor visibility is not as likely to be a factor in the events leading to a grounding or ramming as it is in an encounter with another vessel. The vessel encounter is an unknown and dynamic situation, a surprise situation to some extent, in which an impediment to early sighting and tracking might be expected to cause special difficulty.

Conversely, the three charts on wind speed (Charts 3.21 - 3.23) show that rammings and groundings are more likely than collisions to occur when the wind speed is high:

	<u>Collisions</u>	<u>Groundings</u>	<u>Rammings</u>
Wind speed over 10 knots	21 percent	33 percent	38 percent

Sea swell is not a precipitating factor in the accidents studied except possibly in grounding accidents (sea swell over 4 feet reported in 11 percent of the cases).

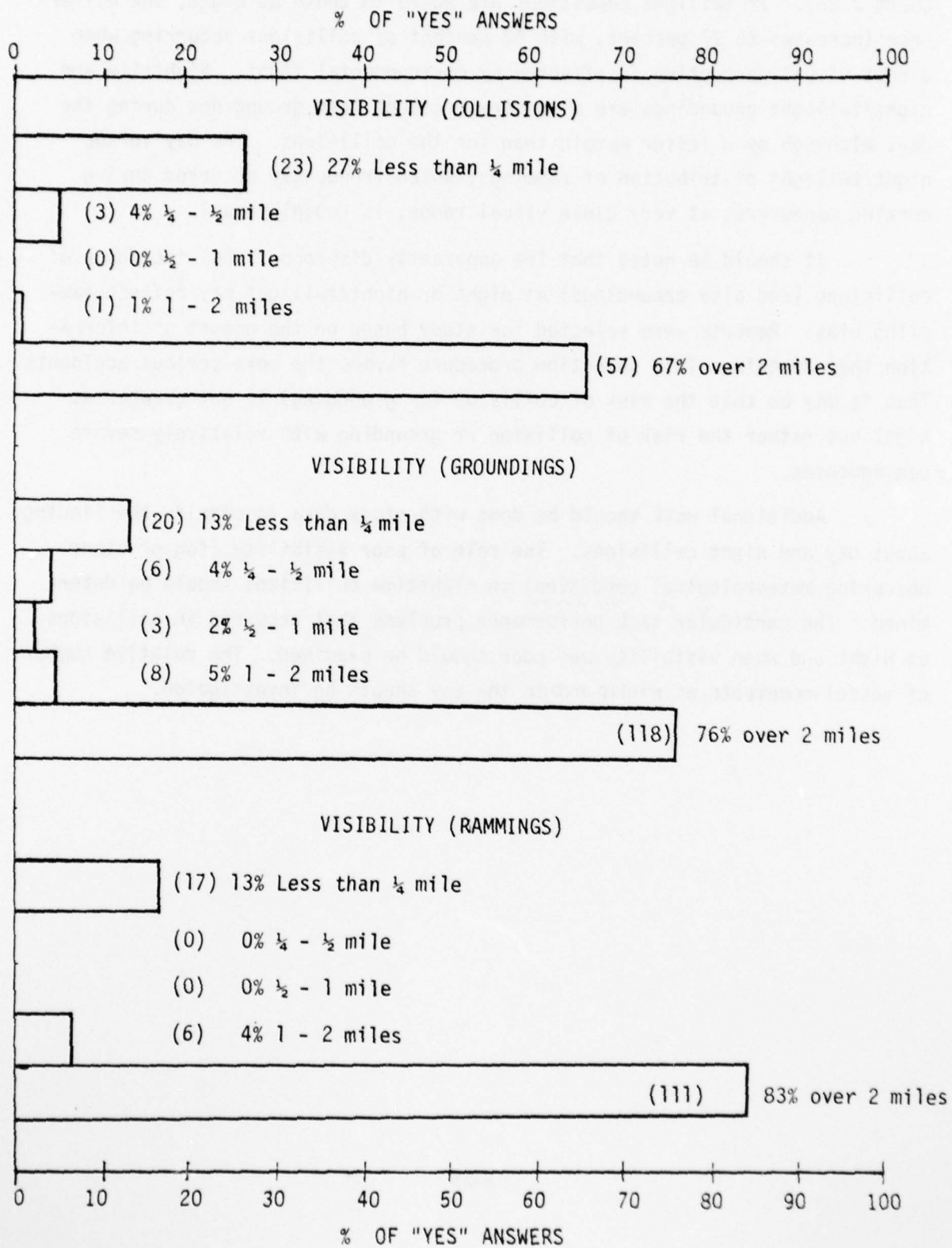
The time-of-day results appear to be significant if it can be assumed that harbor operations are essentially evenly distributed or that daytime traffic exceeds night traffic. Vessel personnel report no appreciable difficulty in nighttime navigation and maneuvering, although it is evident that the amount of visual information available to an operator decreases at night. What during the day may be recognized immediately as another underway vessel is perceived at night as an array of lights which must be closely and continuously scrutinized to determine its identity, size, and movement. In a harbor area with numerous dock lights, lighted aids, and background lights, the timely identification of particular lights as belonging to another vessel is a more difficult task. The problems of unlit hazards at night are self-evident.

Nighttime collisions exceed day collisions by 20 percent (from Chart 3.25). If twilight conditions are added to those at night, the difference increases to 27 percent, with 63 percent of collisions occurring when direct visual perception is affected by environmental light. Nighttime and night/twilight groundings are also more frequent than groundings during the day, although by a lesser margin than for the collisions. The day versus night/twilight distribution of rammings, which frequently occurred during docking maneuvers, at very close visual range, is roughly equal.

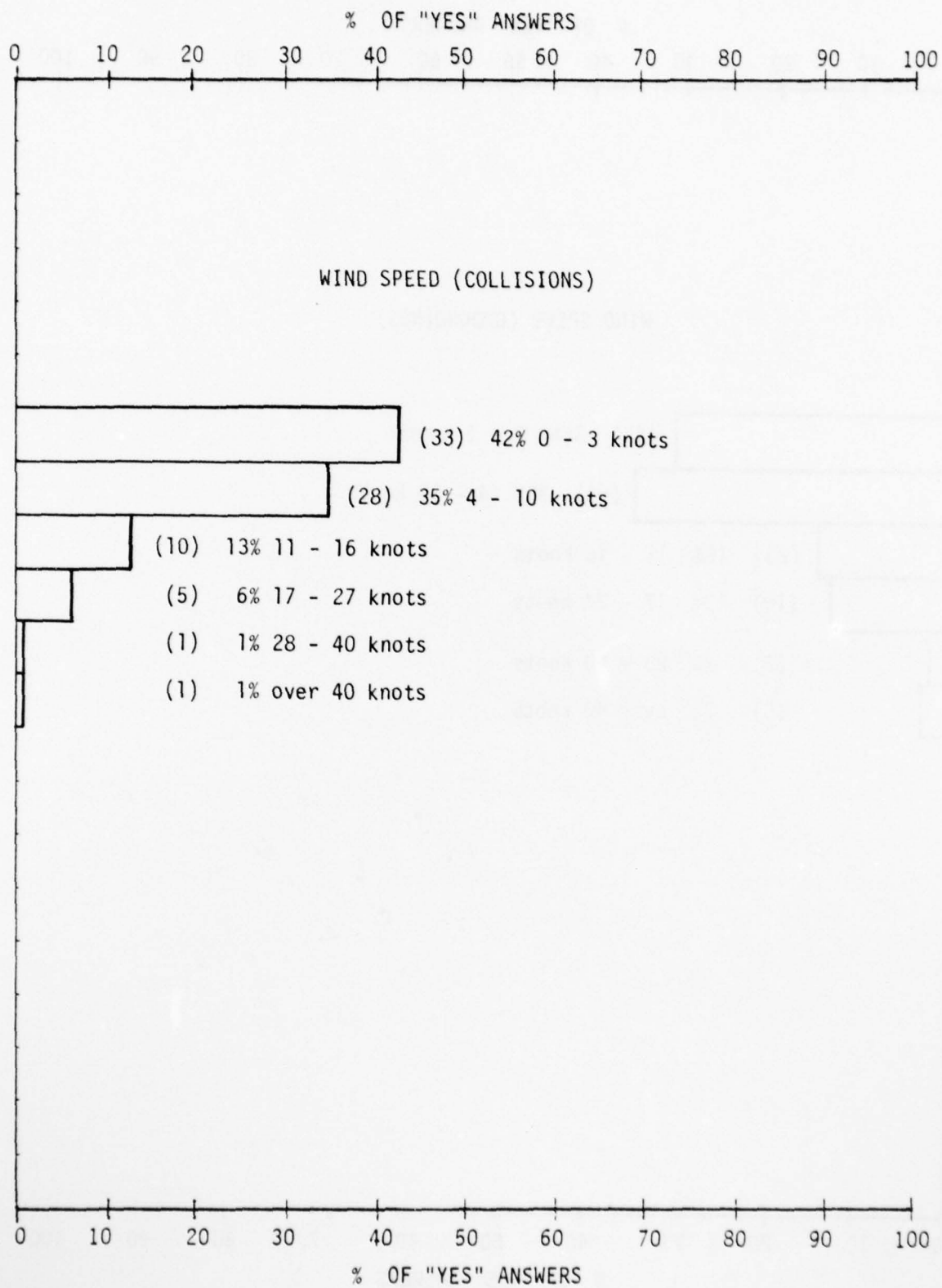
It should be noted that the apparently disproportional incidence of collisions (and also groundings) at night or night/twilight may reflect sampling bias. Reports were selected for study based on the amount of information they contain. This selection procedure favors the more serious accidents. Thus it may be that the risk of collision (or grounding) is not greater at night but rather the risk of collision or grounding with relatively severe consequences.

Additional work should be done with study data to clarify the findings about day and night collisions. The role of poor visibility (fog or other obscuring meteorological condition) in nighttime collisions should be determined. The particular task performance problems that occurred in collisions at night and when visibility was poor should be examined. The relative number of vessel movements at night and in the day should be investigated.

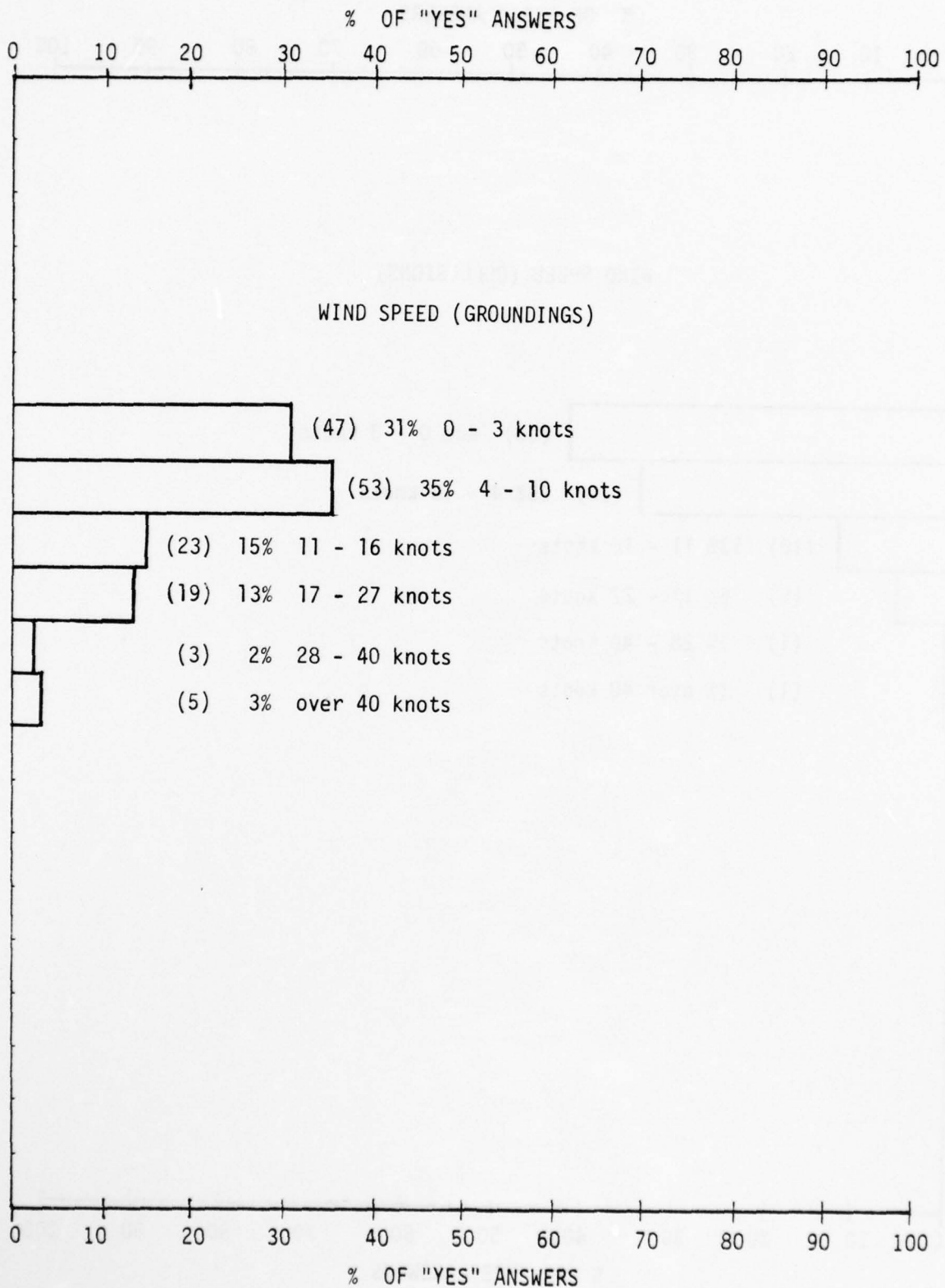
ENVIRONMENTAL CONDITIONS - CHART 3.20



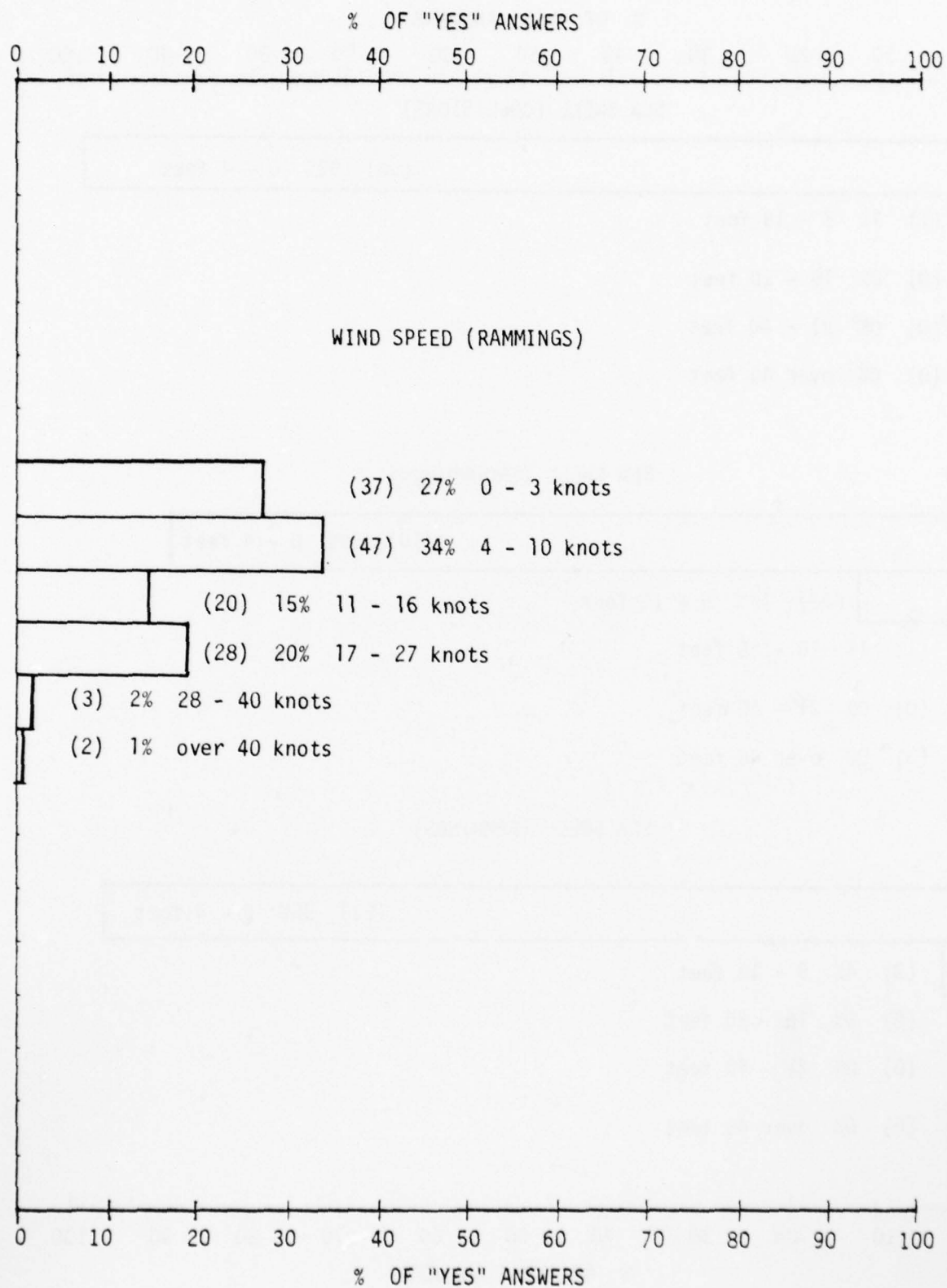
ENVIRONMENTAL CONDITIONS - CHART 3.21



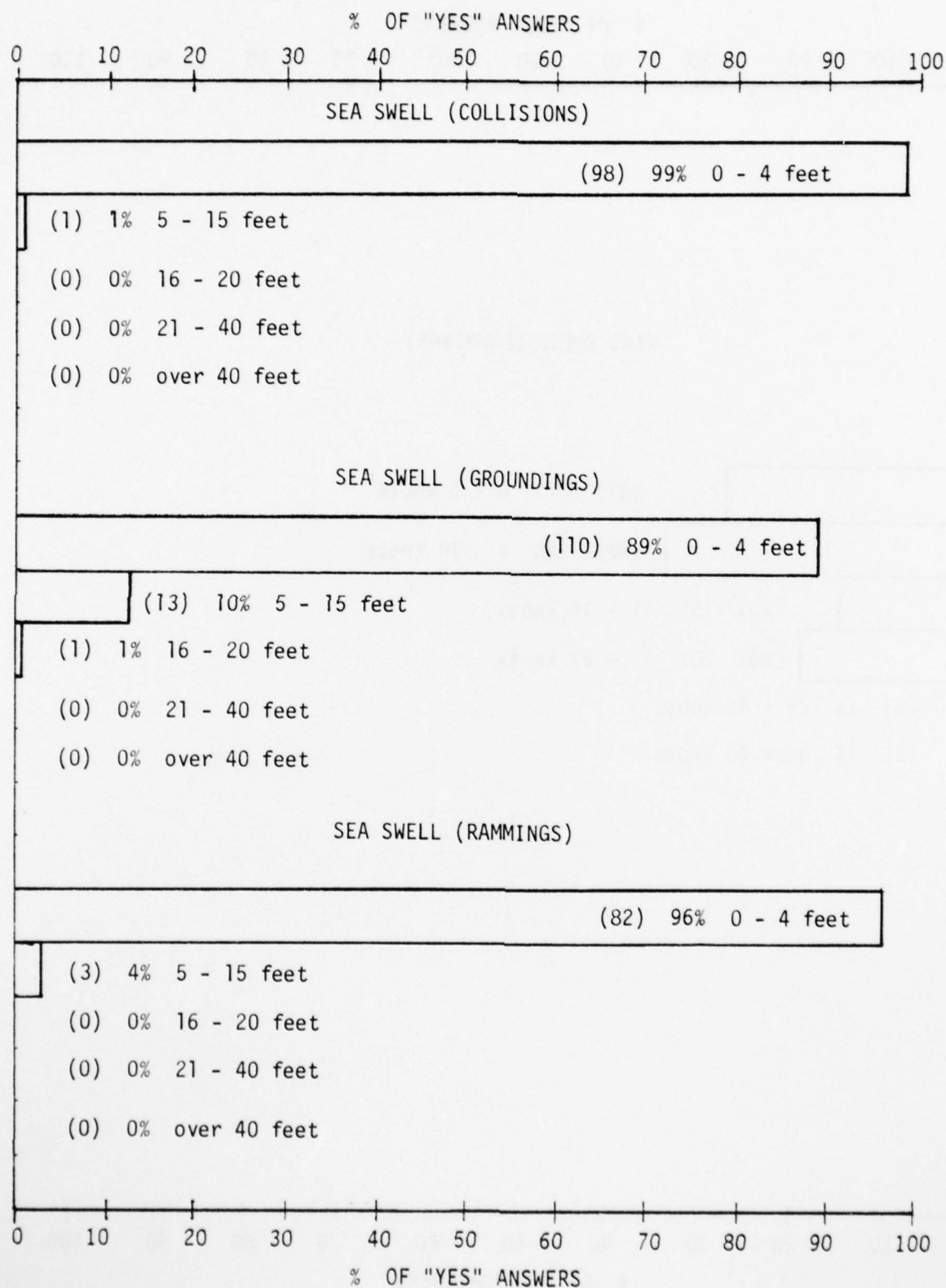
ENVIRONMENTAL CONDITIONS - CHART 3.22



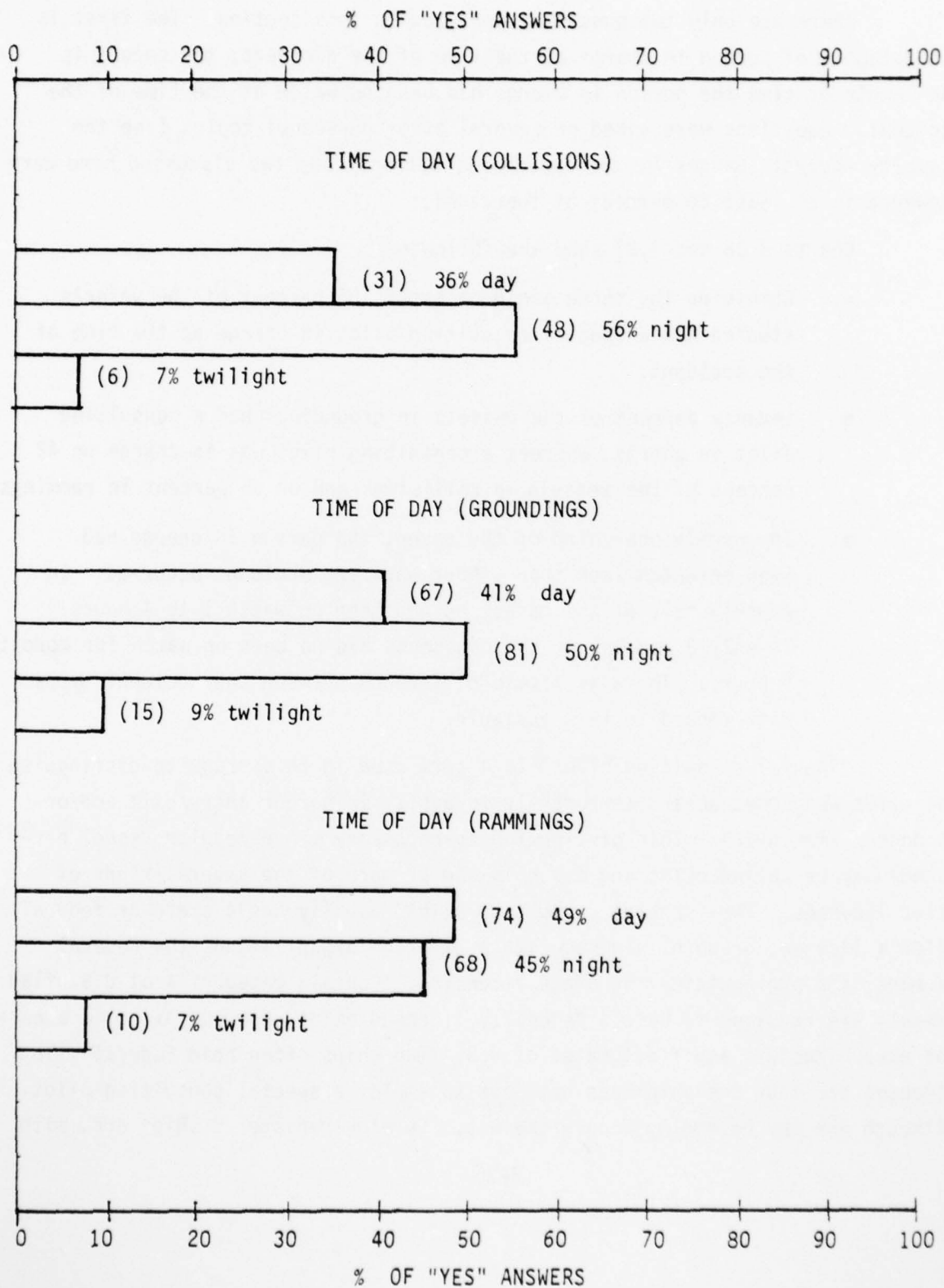
ENVIRONMENTAL CONDITIONS - CHART 3.23



ENVIRONMENTAL CONDITIONS - CHART 3.24



ENVIRONMENTAL CONDITIONS - CHART 3.25



PERSONNEL INFORMATION

There are only two questions analyzed in this section. The first is the category of person in charge at the time of the accident; the second is the length of time the person in charge had been on watch at the time of the accident. Questions were asked on several other personnel topics (see the Casualty Analysis Gauges in the appendix), but only the two discussed here were answered in at least 60 percent of the cases.

Charts 3.26 and 3.27 show the following:

- Combining the three accident types, 56 percent of the vessels studied had a special consulting pilot in charge at the time of the accident.
- Seventy percent of the vessels in groundings had a consulting pilot in charge, whereas a consulting pilot was in charge on 42 percent of the vessels in collisions and on 55 percent in ramming.
- In roughly one-third of the cases, the person in charge had been on watch less than 1 hour when the accident occurred. In roughly half of the cases, he had been on watch 1 to 4 hours. In only 3 percent of the accidents had he been on watch for more than 9 hours. There is little difference between the accident types with regard to this variable.

"Special consulting pilot" is a term used in this study to distinguish the pilot who comes aboard temporarily to assist in harbor entry/exit and/or in docking maneuvers. This distinction is necessary since regular vessel personnel may be called pilot and may hold one or more of the several kinds of pilot licenses. The "special consulting pilot" usually has a state or federal pilot's license, or both. In some state pilotage organizations the Federal license is a prerequisite for state licensing. Certain categories of U.S. flag vessels are required to have a Federally licensed pilot when operating in a harbor area. Masters and first mates of U.S. flag ships often hold Federal pilot licenses and thus the ship does not have to employ a special consulting pilot, although one may be employed nevertheless. Foreign registered ships are, with

some special exceptions, required to have a state-licensed pilot onboard when entering and exiting U.S. harbors.

Docking pilots and other categories of locally licensed or unlicensed pilots may also serve as special consulting pilots. Docking pilots often work for the tug operating company. They normally take charge, often relieving a state/Federal pilot, just for the docking maneuvers.

In general, a special consulting pilot, especially a state-licensed pilot, can be said to be very familiar with the particular harbor area. He also typically has extensive experience over the range of the types of commercial vessels that frequent the area, although he may not have recent experience on a given class, size, or type of vessel. The special pilot's principal function is to provide expert knowledge of local hazards. He also provides expertise in vessel handling in restricted areas since he has more frequent opportunity to perform those tasks than regular vessel personnel. However, the special pilot must rely on the vessel personnel for information about the unique response characteristics of the vessel and its equipment. Vessel personnel perform the lookout, radar and communications watch, fix position, and execute helm and engine orders.

The category of person in charge (Chart 3.26) needs to be considered in relation to vessel type and registry (Charts 3.2 and 3.10). Without cross tabulation, it is evident that a special consulting pilot was in charge in probably all of the foreign flag ships involved in collisions and most of the U.S. ships. There were 61 ships in the study sample of collisions (Chart 3.2). Forty-two were foreign-registered and 19 were U.S.-registered (Chart 3.10). A consulting pilot was in charge in 55 of the collisions. A few of these were on barge configurations (tank barges), but normally they do not employ consulting pilots.

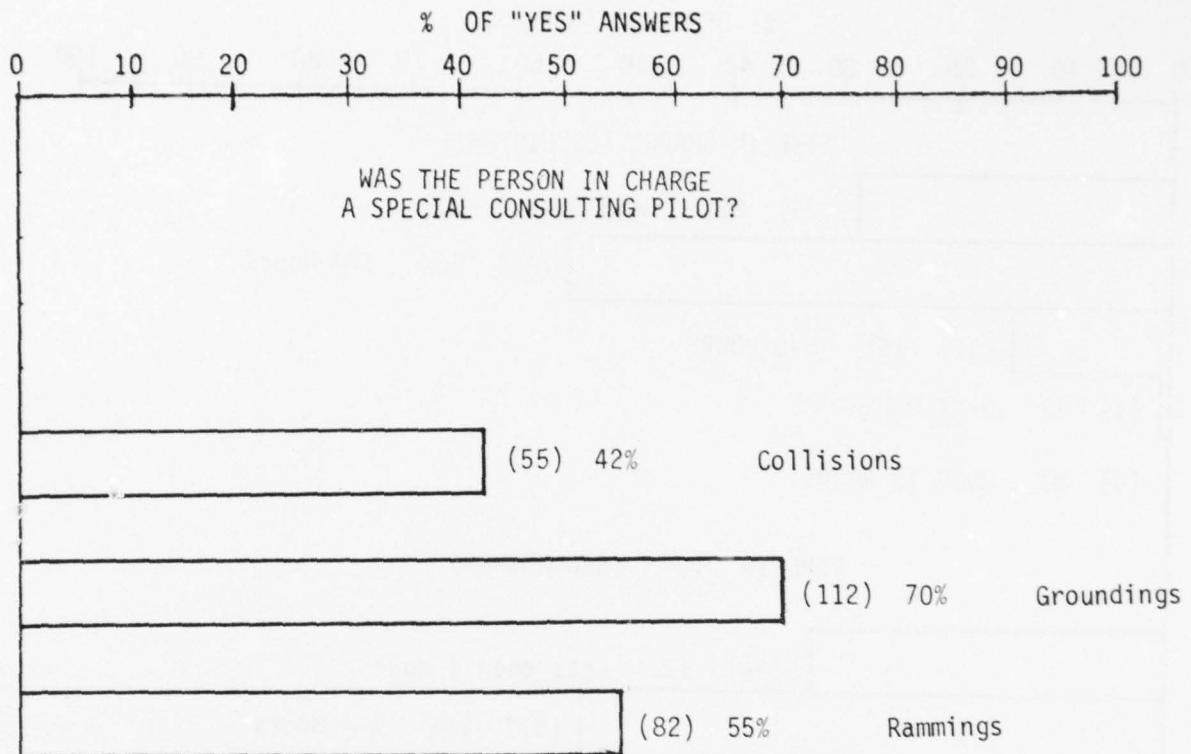
A preponderance of consulting pilots in charge is seen in the grounding cases (70 percent) because a preponderance of the vessels in the study sample of grounding were ships (71 percent). The involvement of consulting pilots in ramming cases (55 percent) similarly mirrors the proportion of ships in the ramming cases (54 percent).

These data do not permit interpretation of the category of person in charge as an accident factor. The accident sample appears to reflect faithfully the rules of pilotage and accepted prudent practice concerning use of pilots in harbor areas. It would be desirable to analyze the questions on specific licenses held by these pilots to compare those data to baseline data on working pilots in general and also to obtain baseline data on the relative frequency of U.S. and foreign ship port calls.

It has been conjectured that watch fatigue or boredom may be a factor in vessel accidents. Chart 3.27 provides little support for this premise. However, it is not uncommon for consulting pilots to wait long periods at a shore station or on a pilot boat before boarding the vessel and taking the conn. The accident reports rarely provide information about this possible fatigue factor, which could have affected about half of the persons in charge in the study sample of cases.

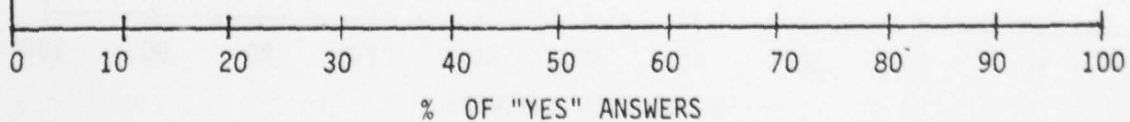
Considering just the information available in Chart 3.27, it may be significant that about a third of the accidents of all types occurred within an hour of assuming the conn. This is slightly above the expected rate assuming an even distribution of accidents over a 4-hour watch. Moreover, harbor entry/exit typically takes longer than 4 hours, at least for a ship, and the normal ship watch is not observed by the pilot. If a special consulting pilot is in charge, he normally stays on the bridge until the job is done.

PERSONNEL INFORMATION - CHART 3.26



NOTE: This question is vessel-related because there is a person in charge for every vessel of interest.
The base numbers are:

Collision	130
Grounding	160
Ramming	149



AD-A071 058

ORI INC SILVER SPRING MD

F/G 13/10

STUDY OF TASK PERFORMANCE PROBLEMS IN REPORTS OF COLLISIONS, RAM--ETC(U)

MAR 79 B PARAMORE, V KEITH, P KING

DOT-CG-41903-A

UNCLASSIFIED

ORI-TR-1474

USCG -D-28-79

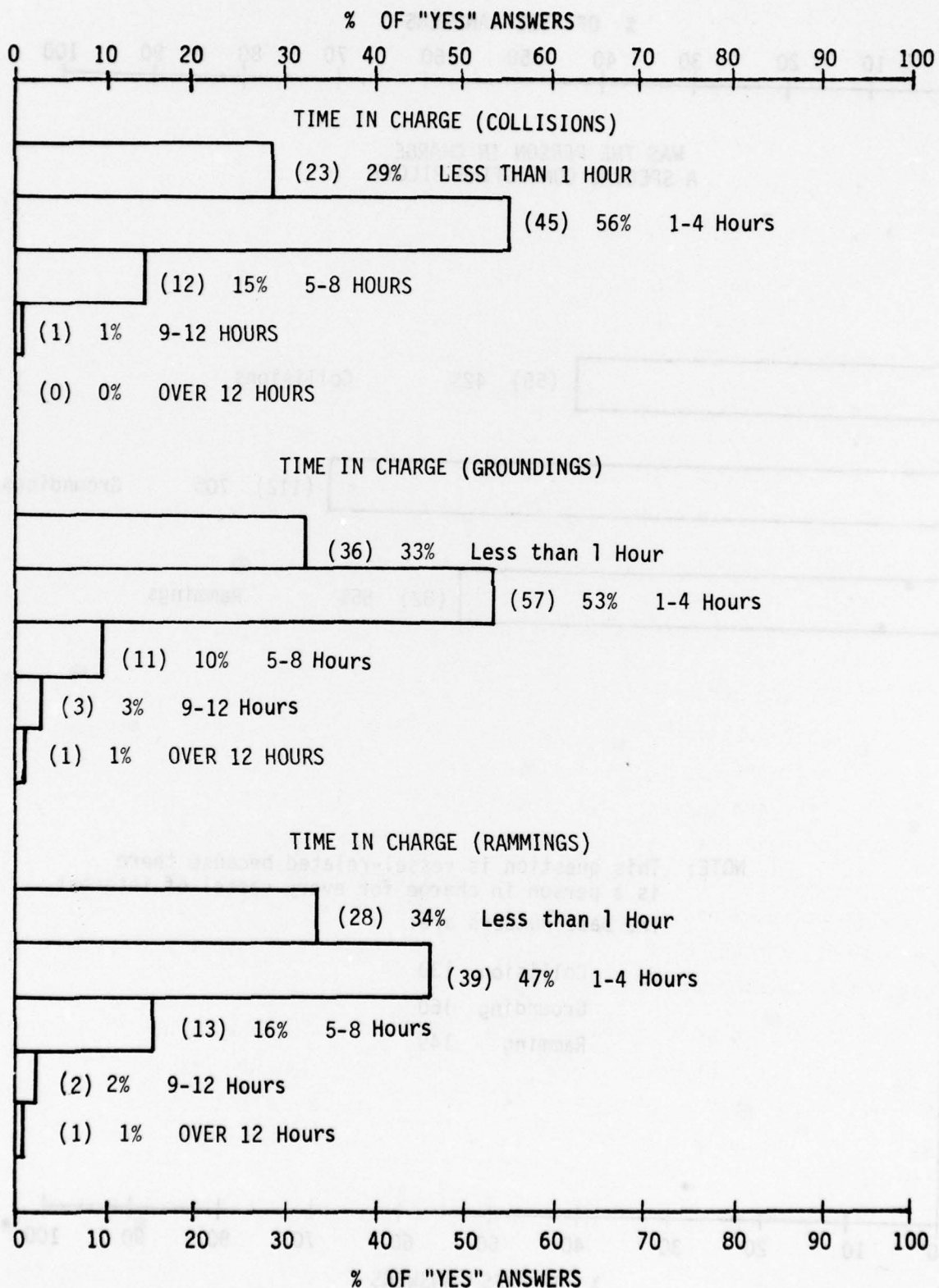
NL

2 OF 4
AD
A071058





PERSONNEL INFORMATION - CHART 3.27



OTHER QUESTIONS

Charts 3.28-3.32 present a number of questions on natural and man-made hazards, on the use of radar, and on the types of meetings that resulted in collisions. The most significant findings are that

- Thirty-six percent of the objects rammed were moored vessels.
- Twenty-eight percent of the rammings occurred at bridges or locks.
- More than half of the rammings at bridges were at drawbridges.
- Between 20 percent and 30 percent of all three types of accidents studied took place in or approaching a sharp (20 deg) turn.
(This finding is based on the number of cases in which a determination could be made.)
- Twenty-five percent of the ships and tugs/towboats involved in collisions did not have their radar on prior to the accident.
(This excludes the special purpose and small craft involved in the collisions.)
- Nearly half of the collision encounters were meeting encounters; about a quarter were overtaking encounters.

Struck Objects in Rammings

Chart 3.28 presents data on the types of objects rammed. Although there were only 154 ramming cases, 160 objects are pinpointed due to a few cases in which more than one object was struck. The cases are fairly evenly divided between vessel rammings, bridge/lock rammings, and dock rammings -- roughly 30 percent each. The most common vessel activities at the time of these rammings were docking and attempting to pass through a bridge. As might be expected, rammings with moored vessels occurred most frequently in congested areas and in docking maneuvers.

It should be noted that it was not specifically asked whether the struck object was a bridge or lock. Instead it was asked whether the vessel was negotiating a bridge or lock at the time of the accident. It is assumed that in rammings while negotiating bridges or locks, the bridge or lock typically was hit.

Chart 3.29 shows the incidence of accidents at bridges or locks for all three accident types. The percentages are based on the number of cases in which the determination could be made. It could not be made in a third of the collision cases; thus the collision results in Chart 3.29 are questionable.

In more than half of the rammings at bridges/locks, the vessel was negotiating a drawbridge. This also is shown in Chart 3.29. Thus drawbridge problems figure in, if not account for, 16 percent of the rammings in the sample. Typically in these accidents, the drawbridge failed to open because of inattention by the bridge operator or failure of the raising mechanism. The vessel operator assumed the bridge would open and undertook no precautions against its failure to do so.

Accidents Near/In Sharp Turns

The fourth question in this section (Chart 3.30) asks whether the vessel was in a sharp turn (>20 deg) at the time of the accident. There is little variation in response rates between accident types, with 26 percent of the total number of cases in the yes category. It should be noted that the collision results are based on roughly a 50 percent response to the question.

Type of Encounter in Collisions

Chart 3.31 is about the type of meeting situation which the two vessels were perceived to be in prior to collision. The type of meeting was rarely explicitly stated in the report. Thus this categorization is largely judgmental, based on the narrative data given.

Relatively few (15 percent) of the collisions were found to develop from crossing encounters. This might be expected from the study's focus on harbor areas. The crossing collisions occurred in essentially open areas (e.g., bay) and at channel intersections. A majority of the collisions (70 percent) occurred in defined channels. Meeting encounters account for just under half of the collisions and overtaking encounters account for about 25 percent. The meetings labeled "other" in Chart 3.31 are a miscellaneous group for which enough information was provided in the reports that any other category was deemed inappropriate (e.g., a vessel just leaving a dock strikes an incoming vessel).

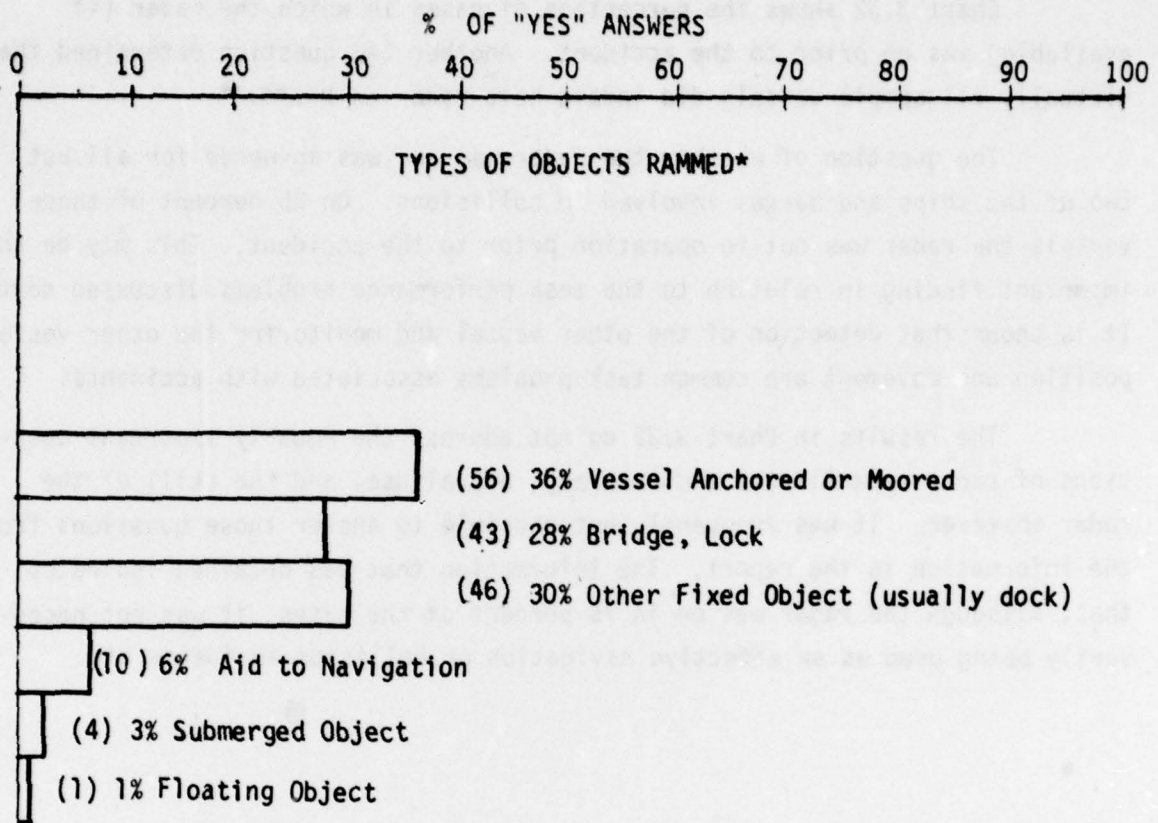
Radar Use

Chart 3.32 shows the percentage of cases in which the radar (if available) was on prior to the accident. Another CAG question determined that virtually all sample vessels did indeed have radar on board.

The question of whether the radar was on was answered for all but two of the ships and barges involved in collisions. On 25 percent of those vessels the radar was not in operation prior to the accident. This may be an important finding in relation to the task performance problems discussed next. It is shown that detection of the other vessel and monitoring the other vessel's position and movement are common task problems associated with accidents.

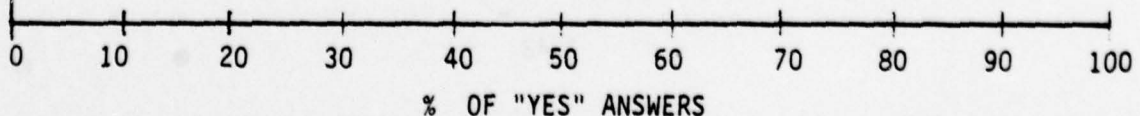
The results in Chart 3.32 do not address the equally important questions of radar capabilities and accuracy, actual use, and the skill of the radar observer. It was frequently not possible to answer those questions from the information in the report. The information that was obtained indicates that, although the radar was on in 75 percent of the cases, it was not necessarily being used as an effective navigation or collision-avoidance aid.

OTHER QUESTIONS - Chart 3.28

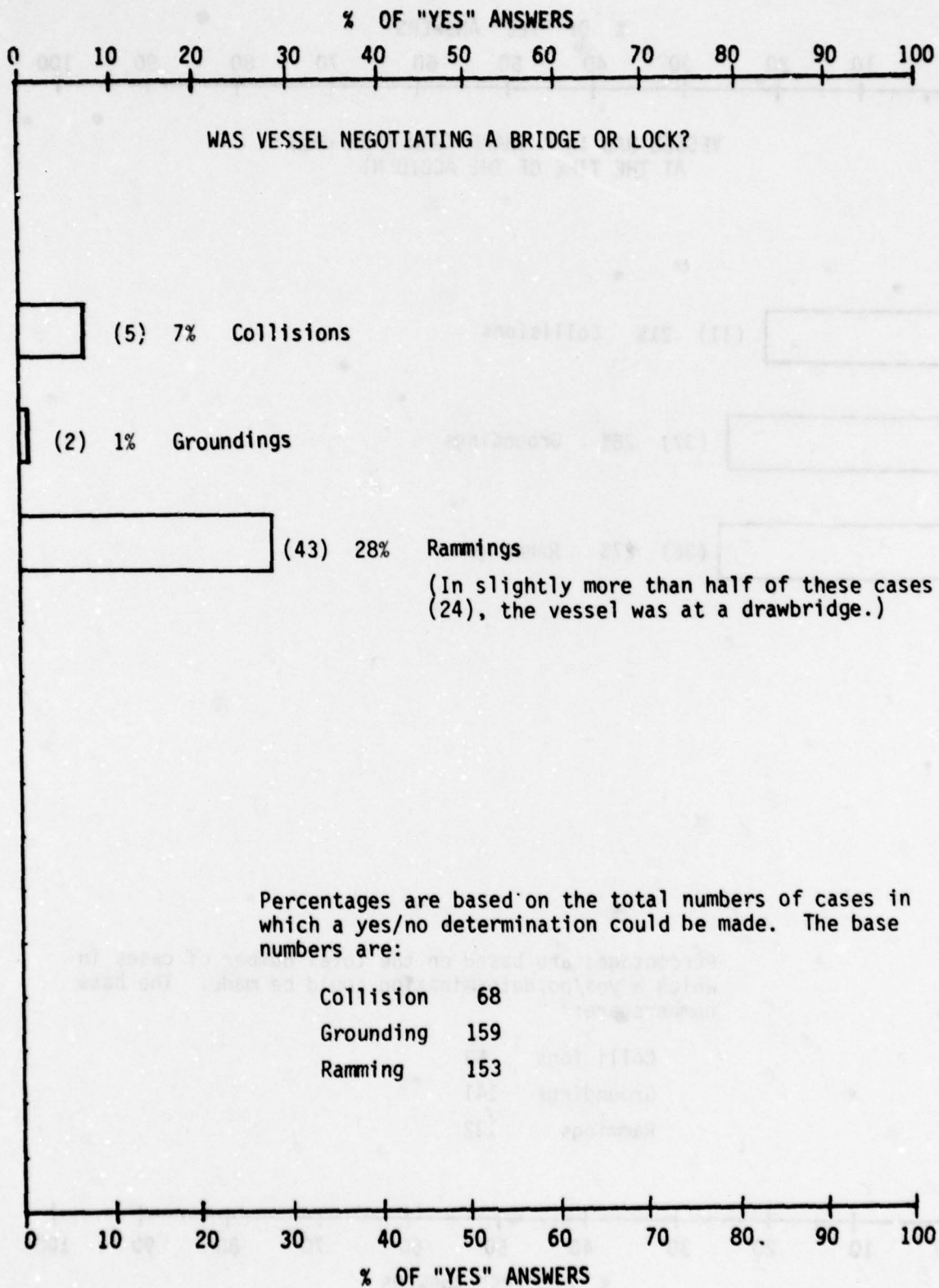


Note: Some of these figures are approximate and are based on assumptions made in the preceding discussion section.

Total number of struck objects exceeds number of ramming cases (154) cases because in a few instances more than one object was struck. Percentages are based on the number of cases.



OTHER QUESTIONS - CHART 3.29

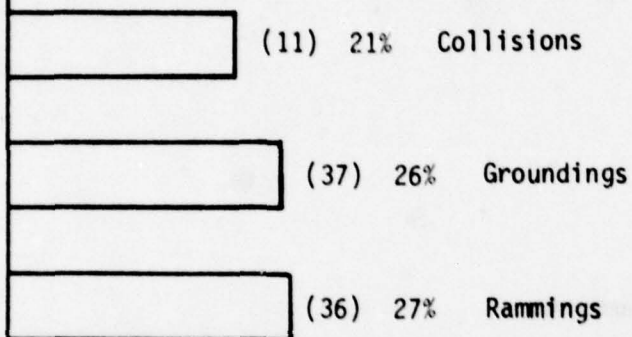


OTHER QUESTIONS - CHART 3.30

% OF "YES" ANSWERS

0 10 20 30 40 50 60 70 80 90 100

VESSEL WAS IN A SHARP TURN (>20 deg)
AT THE TIME OF THE ACCIDENT



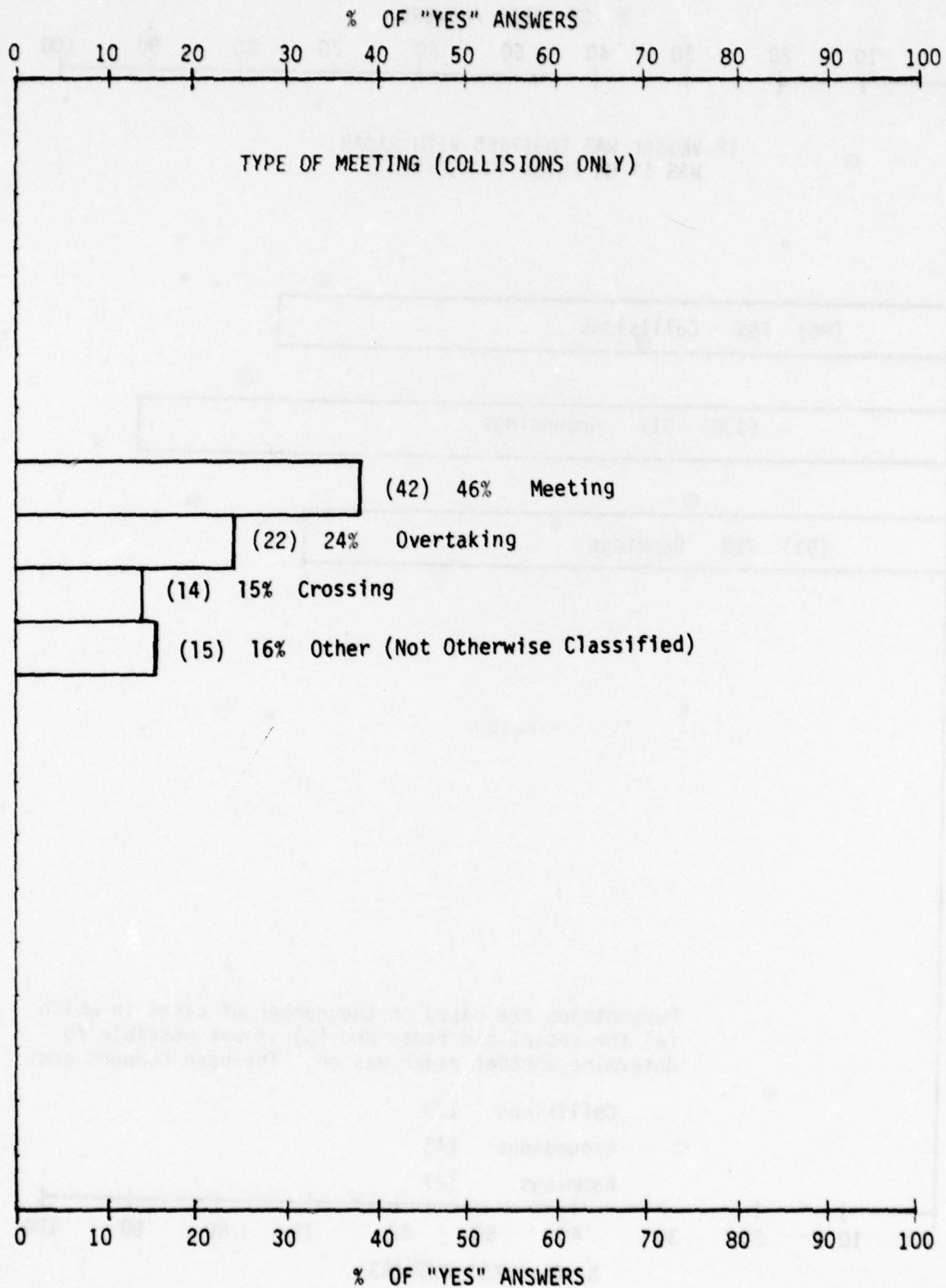
Percentages are based on the total number of cases in which a yes/no determination could be made. The base numbers are:

Collisions	53
Groundings	141
Rammings	132

0 10 20 30 40 50 60 70 80 90 100

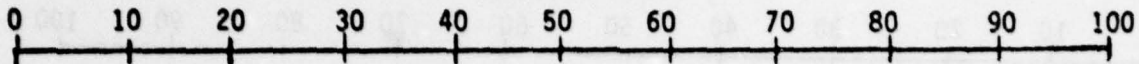
% OF "YES" ANSWERS

OTHER QUESTIONS - CHART 3.31

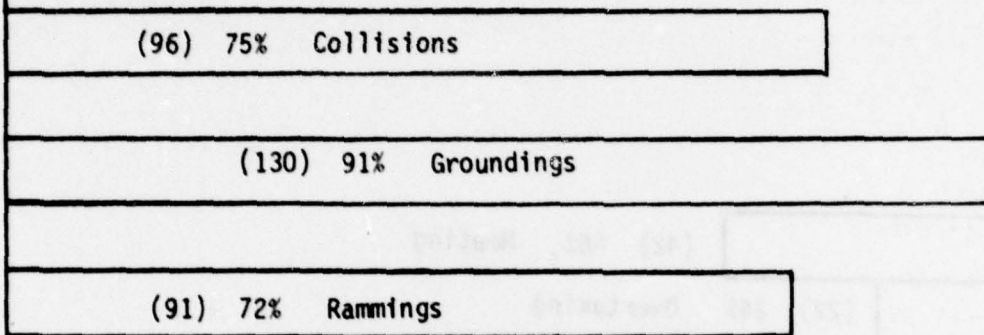


OTHER QUESTIONS - CHART 3.32

% OF "YES" ANSWERS

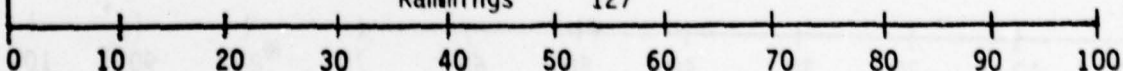


IF VESSEL WAS EQUIPPED WITH RADAR,
WAS IT ON PRIOR TO ACCIDENT?



Percentages are based on the number of cases in which
(a) the vessel had radar and (b) it was possible to
determine whether radar was on. The base numbers are:

Collisions	128
Groundings	143
Ramming	127



% OF "YES" ANSWERS

TASK PERFORMANCE FACTORS

Charts 3.33 - 3.51 address task performance failures which were found to have contributed to the accidents and also factors underlying the task performance failures. Some charts present data on only one or two accident types, depending on whether a particular question is appropriate to all accident types. The charts are subdivided, with each group preceded by an overview of essential points and then more detailed discussion of individual charts. A special effort is made in this section to explain the criteria applied in answering the questions, since they were designed to yield causal interpretations of the report information. The question numbers in the Casualty Analysis Gauges are noted in the charts. "R/G-CAG" refers to the rammings and groundings Casualty Analysis Gauge; "C-CAG" refers to the collision gauge.

A new format for presenting data peculiar to the collision cases is introduced in this section. Each chart offers enough information to show how many vessels were associated with the precipitating factor, and yet the chart still relates the factor to the number of accidents in which it occurred. An example from Chart 3.35 is shown below:

FAILURE TO DETECT

Collisions: 8 Primary Vessel (PV) + 6 Other Vessel (OV) + 15 both = 29/88

This example shows that there were 8 collisions in which only the primary vessel failed to detect a hazard/aid, that there were 6 collisions in which only the other vessel failed to detect a hazard/aid, and that there were 15 collisions in which both vessels failed to detect a hazard/aid. The total on the far right states that 29 out of the 88 collision cases looked at involved a failure to detect a hazard or aid on the part of one or both vessels.

The "primary vessel" is always a ship greater than 10,000 GRT or a tug/towboat-barge configuration. If there were two such vessels in the accident, one was arbitrarily designated "primary" and the other was designated "other." Where a large ship or a barge configuration was involved with a special purpose vessel or small vessel, the latter is the "other" vessel. (The study population is defined to include only accidents that involved at least one ship greater than 10,000 GRT or a tug/towboat barge configuration.)

Exceptional Circumstances

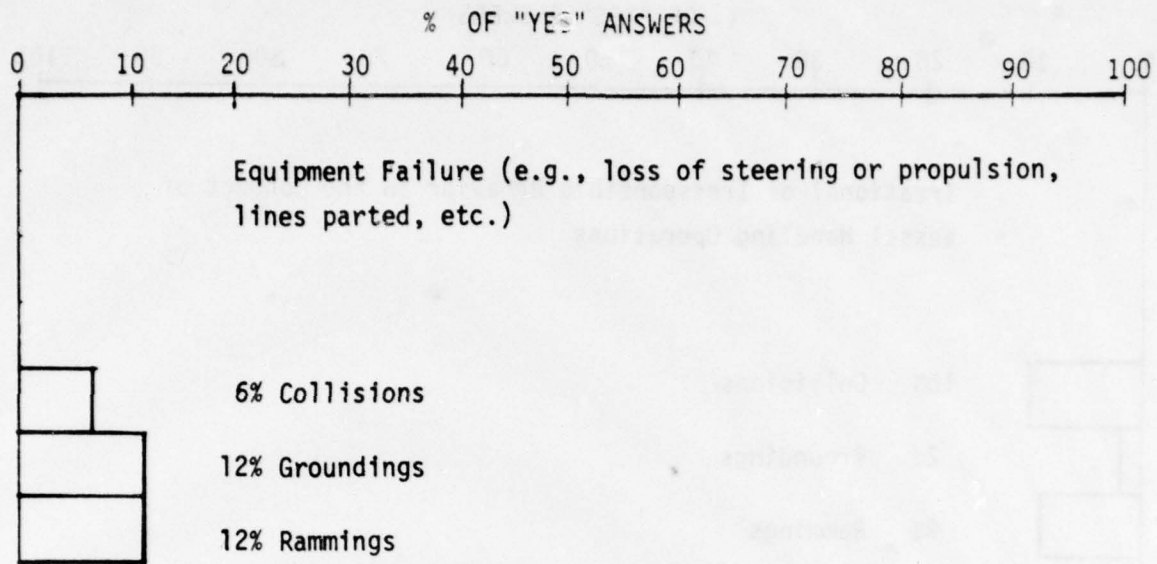
The analysis distinguished three situations in which effective vessel control cannot reasonably be expected: (a) failure of the means of control including propulsion or steering failure, barge breakaway and the like; (b) irrational/irresponsible behavior on the part of vessel handling personnel; (c) "cataclysmic event," such as hurricane, death of helmsman, etc. These kinds of situations were found to be relatively rare:

- 10 percent of all accidents studied involved (often originated with) equipment failure as defined above.
- 6 percent of all accidents studied involved irrational or irresponsible behavior on the part of vessel handling personnel. Irresponsible behavior was cited most often in collision cases (10 percent).
- Only one of the 419 accidents was considered to have involved a cataclysmic event (a hurricane).

Equipment Failure. Equipment failure was defined to exclude problems with navigational equipment or with equipment not onboard ship, such as a drawbridge or malfunctioning light. It does include other onboard problems such as loss of steering, loss of propulsion, parted lines, etc. As shown in Chart 3.33, equipment failure was found to be a factor in 12 percent of both ramming and groundings. The factor is predictably less common in collisions (6 percent) because only in tight situations with other vessels close at hand would a sudden failure result in a collision.

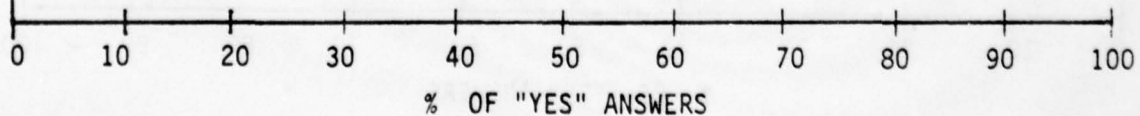
Irrational or Irresponsible Behavior. This category most commonly included the person in charge being asleep or drunk, leaving a completely inexperienced person alone at the helm, or otherwise clearly abdicating his responsibilities for vessel control. These exceptional behaviors appeared as causal factors in 10 percent of the collisions, 9 percent of the ramming, and only 2 percent of the groundings (Chart 3.34). It should be noted that in 9 of the 10 collision cases attributed to irresponsible behavior, it occurred on the "other" vessel, where the other vessel was not a large commercial ship or barge configuration.

CASUALTY PRECIPITATING FACTORS - CHART 3.33

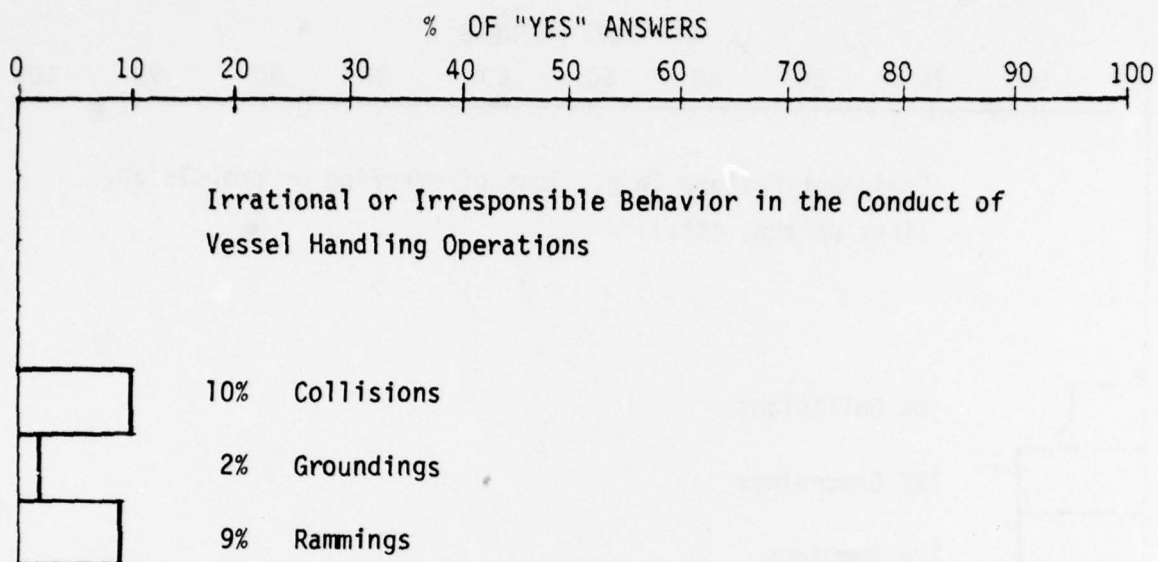


These percentages reflect the answers to question VI. 17 in the R/G-CAG and questions XII. 14 and XII. 15 in the C-CAG.

Collisions	2 PV only + 4 OV only = 6/103
Groundings	20/162 .
Ramblings	18/154

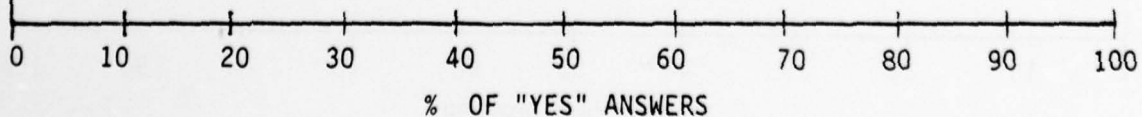


CASUALTY PRECIPITATING FACTORS - CHART 3.34



These percentages reflect the answers to question VI.19 in the R/G-CAG and XII.12 and XII.13 in the C-CAG

Collisions	1 PV only + 9 OV only = 10/103
Groundings	3/162
Rammings	14/154



Cataclysmic Events. Out of a total of 419 cases, only once did something occur which could be labeled a cataclysmic event and it resulted in a ramming. A cataclysmic event was thought of as some rare, precipitous happening such as a hurricane, death of a helmsman, or explosion.

Problems in Performance of Vessel Control Tasks

Charts 3.35 - 3.39 address basic vessel control task requirements that were not fulfilled during the sequences of events leading to the accidents. These task requirements are all part of the information-gathering and decision-making functions of vessel control. They include:

- detection of hazards and aids to navigation
- identification of hazards or aids to navigation¹
- establishment of navigational position
- maintenance of navigational position
- evaluation of potential hazards and decision-making as to appropriate action.

Charts 3.35 - 3.39 show the following:

- A third of both collisions and groundings involved a failure to detect a hazard or aid.
- In more than a third of ramming and groundings, a hazard or aid was not fully identified.
- Over 60 percent of the ramming and groundings were related to an inability to maintain position.
- In over half of the collisions studied, at least one vessel did not monitor the other vessel's progress (did not fully identify the changing hazard).
- Almost half of the collisions involved a failure to evaluate a potential hazard and decide on appropriate action.

¹ "Identification" as used here means precise determination of the identity, nature, force, direction of the phenomenon observed. For example, a lighted aid might be detected but its number not accurately determined. A vessel might be detected but perceived as moving when it is in fact stopped or moored. A cross current might be detected or anticipated but its force and effect on the vessel underestimated or overestimated.

The five information-gathering and decision-making tasks listed on the preceding page are seen as general categories which, along with communication and execution of helm and engine orders, encompass the range of activities that result in any successful passage. These categories are outgrowths of the task analysis study cited in Section II. Virtually every accident can be said to be a result of a breakdown in one or more of these operations. This subsection will explain the interpretation of the question as coded and take a look at the resulting response rates.

Communications problems unique to collisions are treated separately, along with other collision-unique topics, after the common task areas are discussed. Execution of helm and engine orders was not frequently found to be a problem area in the study sample of accidents.

The summary table below reveals that it was not uncommon for two of the five general categories to be scored for the same case. For example, if a poorly defined current pushes a vessel into a bridge support then both failure to fully identify (the hazard of the current) and failure to maintain position were checked as equally significant causal factors.

TABLE 3.1
INCIDENCE OF TASK PERFORMANCE FACTORS IN ACCIDENTS OF EACH TYPE

Task Performance Factor	Collision	Grounding	Ramming
Failure to:			
Detect a hazard or aid to navigation	33%	33%	10%
Identify a hazard or aid to navigation	52%	36%	38%
Establish navigational position	18%	12%	8%
Maintain proper position	36%	61%	64%
Evaluate the navigational situation	<u>41%</u>	<u>12%</u>	<u>19%</u>
Sum of percentages	180%	154%	139%

Assuming that almost all cases had at least one of these five categories checked (readers reports), roughly 35 percent of the rammings and 50 percent of the groundings had multiple scoring of these five questions. The large percentage of collisions showing multiple scoring of these five questions (80 percent) is additionally a function of the fact that a precipitating factor could originate in either colliding vessel (e.g., failure to detect in one vessel, failure to evaluate in the other).

It will be noted that the maximum number of collisions in this series and subsequent charts is 88 rather than 103 (the actual number of collision cases in the study sample). The reason is that the task-related questions were not answered when a collision was attributed to exceptional circumstances (steering system failure, etc.) as just discussed. These circumstances were predicated to overshadow any other factors to such an extent that the others lacked real causal significance. A simplistic example might be that, if the person in charge (PIC) is asleep ("irresponsible behavior"), failure to maintain position would not be considered a causal factor in the accident. The coding was simply omitted for collisions because of the large number of questions involved.

A similar logic was not adhered to in the rammings and groundings CAG. When there were exceptional circumstances, other factors also were coded as pertinent to the scenario. This happened because the logic concerning exceptional circumstances was not explained to the coders clearly enough and a skip instruction was not written into the CAG. In view of the small numbers of cases involved it was decided that this discrepancy between the collision data and the rammings and groundings data would not be harmful.

Failure to Detect Hazard or Aid to Navigation. It was found that about one third of all collisions and groundings studied involved a failure to detect a particular hazard or aid. In the collision cases, the hazard/aid was most often the other vessel; in the grounding cases, it was most often the area of low water or a navigational landmark that was completely missed.

Detection of a hazard/aid was interpreted by those coding the cases as the initial step in an information gathering process that is complete when a particular hazard/aid is fully identified and, as applicable, its

movements, intentions and potential effects on own vessel are clearly recognized. Detection was considered to be a process which stated nothing more than "There (that light ahead, or that radar blip, or that vessel leaving the dock) is something that may possibly be a hazard or aid and should be looked into more fully." If the hazard/aid was detected late, this too was labeled as a failure to detect.

Failure to Fully Identify or Correctly Identify a Hazard or Aid.

Fully identifying or correctly identifying a hazard or aid is a completion of the information gathering process begun when the hazard or aid was first detected. This question was geared toward gauging how often the information that an operator is receiving about a previously detected hazard/aid is inadequate. Some common examples of failures as coded are given below:

- Misinterpretation of lights - mistaking a light to mean something that it does not.
- Environmental effects - inability to understand or predict the effects of currents, tides, suction and winds on the vessel.
- Incomplete information - unexpected hazards such as a lighted towboat with an unlighted barge on a hawser.
- Inadequate monitoring - (collisions only). There is a failure in fully identifying the hazard if the other vessel is seen but its position relative to own vessel is not properly monitored.

Over half of the collisions studied involved some type of breakdown of these sorts. The most common failure to identify as far as collisions are concerned is inadequate monitoring. This problem differs from other failures by the fact that in most cases where failure to monitor was noted, important information (where is the other vessel headed, at what speed, etc.) was available but not being actively gathered in any systematic fashion. Most other failures to identify originated in an inability to collect the data.

Over a third of the ramblings and groundings studied were also associated with the problems of hazard/aid identification. A majority of these were related to an inability to fully understand the magnitude of environmental factors (wind, current) and their effects on the vessel.

Failure to Establish Navigational Position. Failure to establish navigational position was found to be a precipitating factor in 12 percent of all the accidents studied. To be considered a precipitating factor, it had to be considered significant that the operator was not aware of his vessel's position and/or orientation relative to some hazard or that the person in charge felt certain as to his whereabouts but was incorrect. This was found most often in collisions that occurred during periods of poor visibility, when a vessel would gradually move across a channel into the way of an oncoming vessel. Cases in which the PIC knowingly directed the vessel to a hazardous or inappropriate location were coded as failures in evaluation.

Failure to Maintain Position. This is the most common of all problems cited in the causal factors section. Maintaining position was found to be a problem in over 60 percent of both ramming and groundings cases and in 36 percent of the collision cases. The criteria for coding failure to maintain position is related to a vessel's inability to realize an intended path. These "intended paths" were not irrational hopes such as wanting a 10,000 GRT vessel doing 5 knots to stop in 100 yards, but were considered to be more reasonable expectations of what the vessel could do. Some examples are: a PIC on a barge intending to position his vessel close to a bridge support in order to get in line for an upcoming turn finds suction (or wind or current) forces the barge to scrape the bridge support; a barge is pushed aground by high seas; a ship in a turn reacts surprisingly slowly, crosses the channel and strikes an oncoming vessel.

Current, wind, and suction effects near structures and channel banks predominate as contributing or underlying factors in cases of failure to maintain position leading to the groundings and ramming. In the collision cases, failure to maintain position is less often attributed to the effects of environmental forces.

Failure to Evaluate Potential Hazard and Decide on Appropriate Action. This question attempted to separate problems in evaluating information from problems related to the amount and quality of the information input. Failure to evaluate could be demonstrated by either failure to act or action inappropriate for the situation. This question would be scored "yes" only if it could

be reasonably inferred that all relevant information was available to the person in charge. This type of breakdown arose most frequently in collision cases (48 percent), where an operator was often found to recognize another vessel as a potential threat but took no action to assure a safe, unambiguous passing.

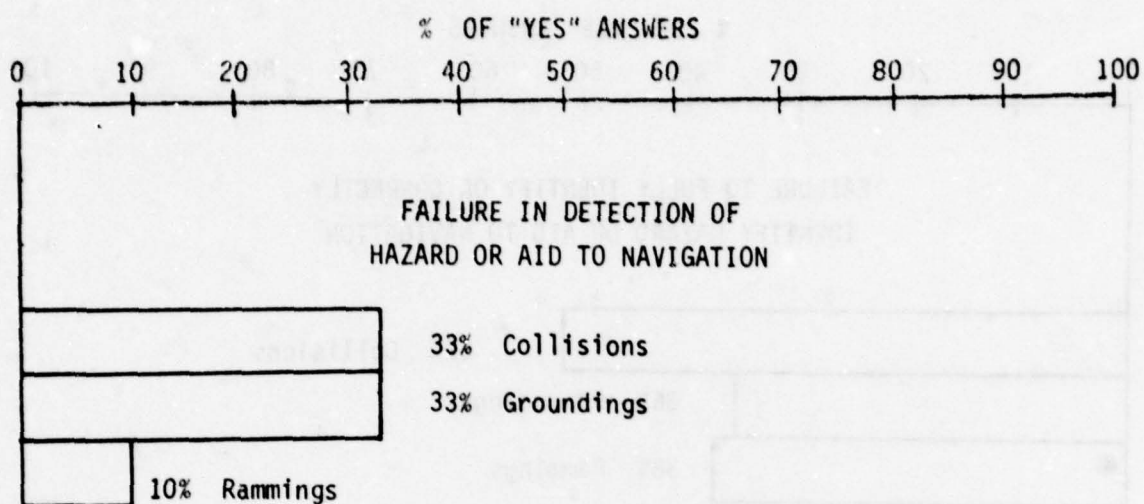
Failure in evaluating hazards was cited as a precipitating factor far less often in groundings (12 percent) and in rammings (19 percent).

Failures in Execution of Navigational Orders. This question concerns inability, confusion, or unwillingness in executing rudder or engine orders as given by the person in charge. The most common of these was a temporary confusion on the part of a crew member (most often the helmsman). This type of problem was found to be relatively uncommon, as shown in Chart 3.40. The greater frequency of failure in the execution of navigational orders in rammings and groundings as compared to collisions might reflect greater maneuvering limitations in the areas where ramming and groundings tend to occur.

Speed. Chart 3.41 shows that speed (either too fast or too slow) was coded as a precipitating factor in 20 percent of the collisions. The typical case is excessive speed in fog. Inappropriate speed was coded as a factor only if a statement directed at that topic was made in the narrative section of the accident report or in the Coast Guard investigating officer's remarks.

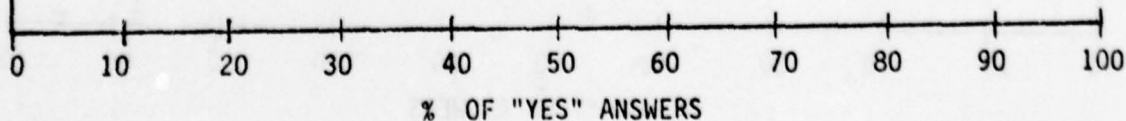
The proportion of speed-related groundings and rammings is less than half that of collisions, probably because the groundings and rammings tend to occur in more highly restricted places.

CASUALTY PRECIPITATING FACTOR - CHART 3.35

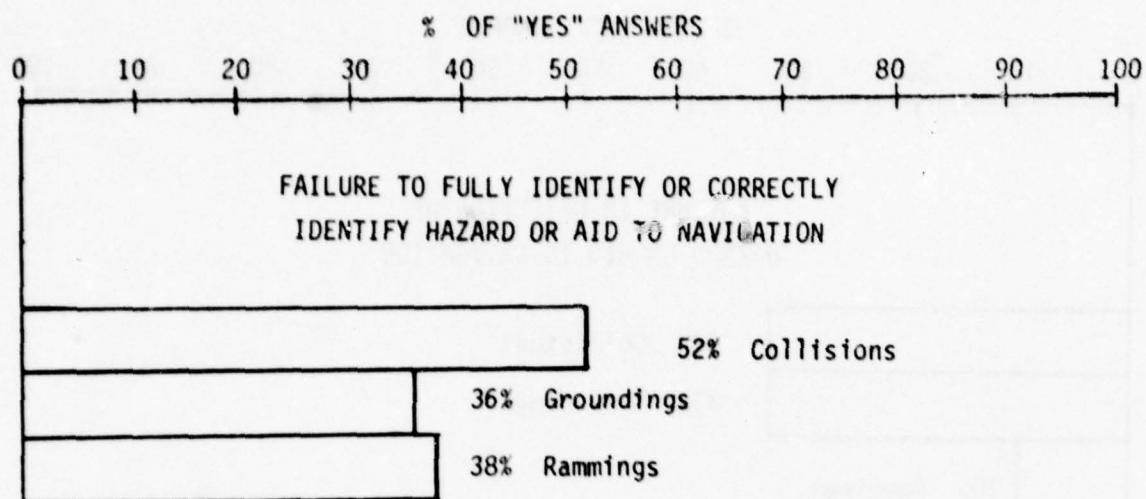


The percentages reflect answers to question VI. 11 in the R/G-CAG and questions XII. 37 and XII. 38 in the C-CAG.

Collisions	8 PV only + 6 OV only + 15 both = 29/88
Groundings	53/162
Rammings	15/154

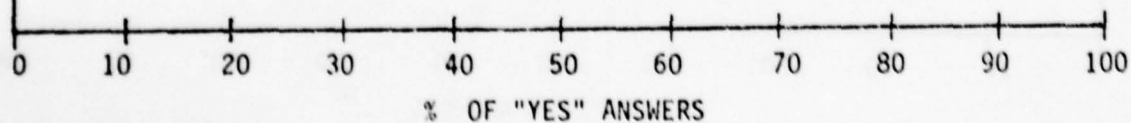


CASUALTY PRECIPITATING FACTORS - CHART 3.36

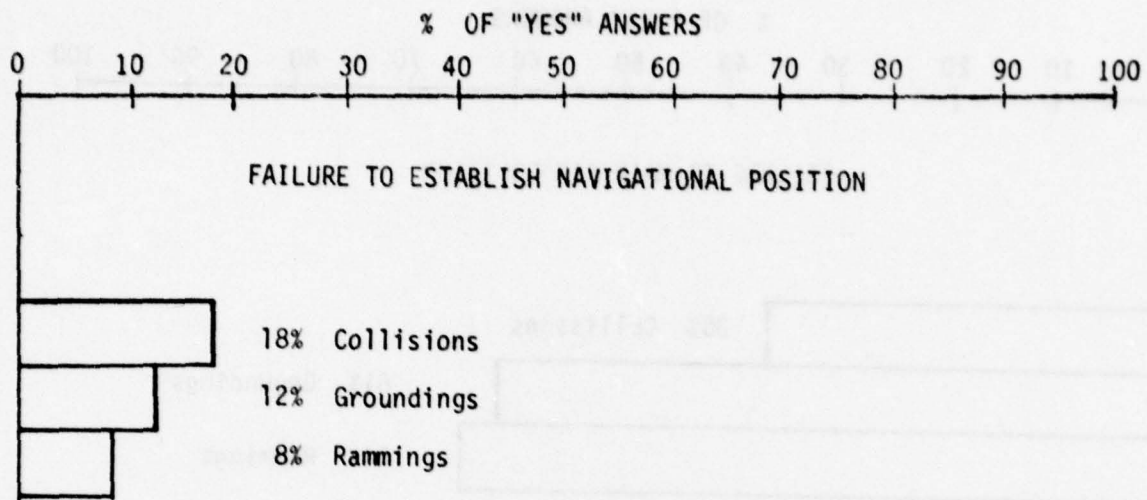


The percentages reflect the answers to question VI. 12 in the R/G-CAG and questions XII. 48 and XII. 49 in the C-CAG.

Collisions	12 PV only + 9 OV only + 25 both = 46/88
Groundings	59/162
Rammings	58/154

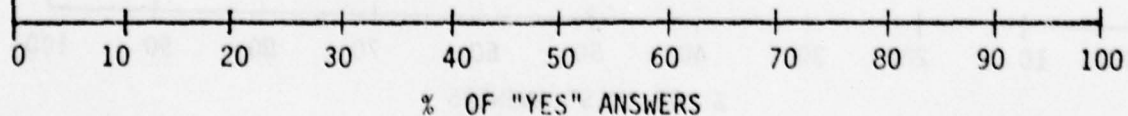


CASUALTY PRECIPITATING FACTORS - CHART 3.37

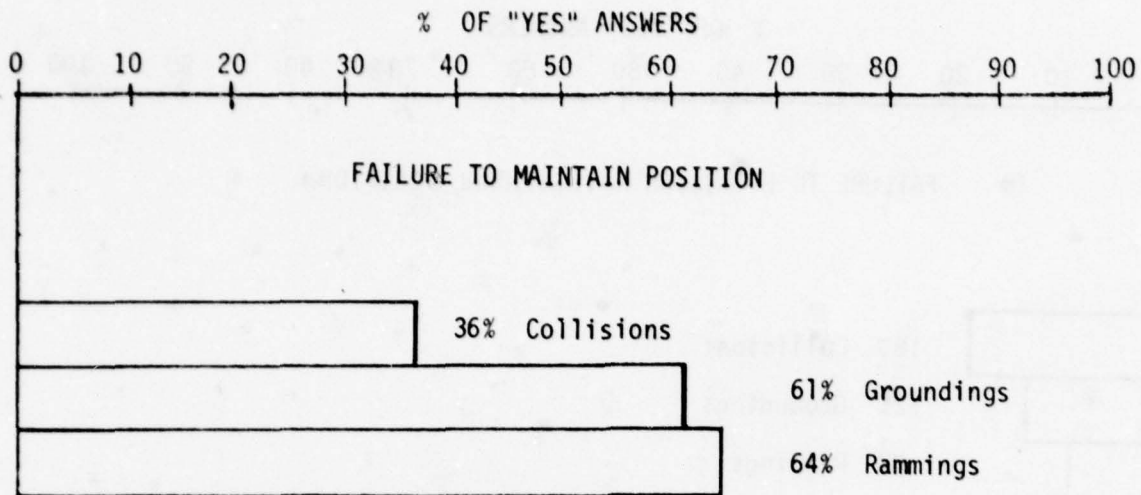


The percentages reflect answers to question VI. 13 in the R/G-CAG and questions XII. 50 and XII. 51 in the C-CAG.

Collisions 3 PV only + 8 OV only + 5 both = 16/88
 Groundings 20/162
 Ramming 13/154

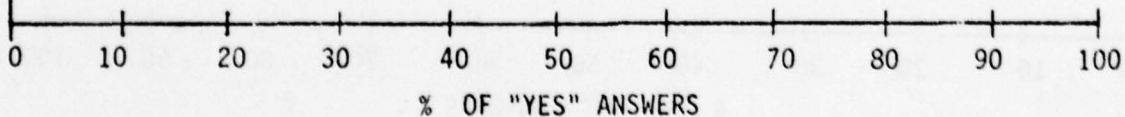


CASUALTY PRECIPITATING FACTORS - CHART 3.38

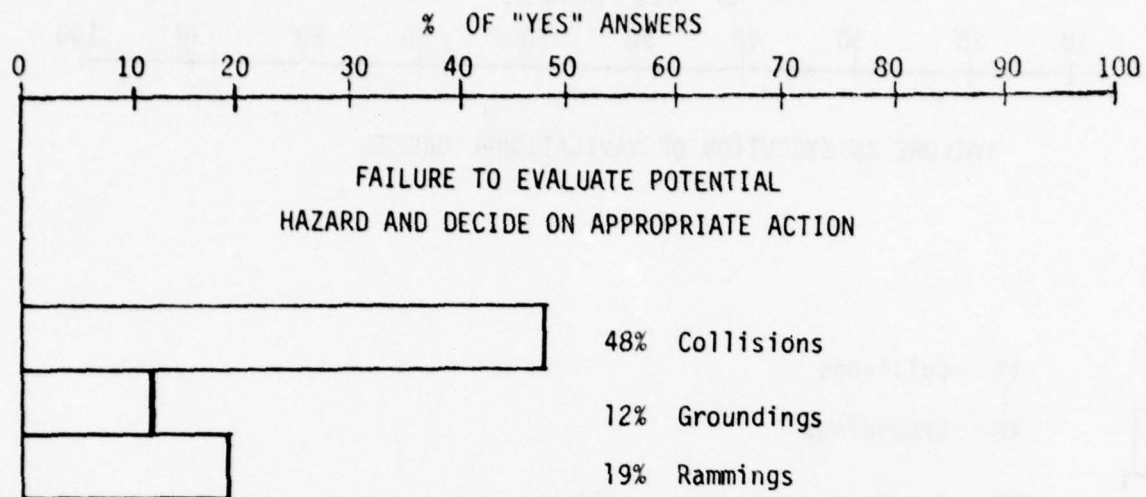


These percentages reflect answers to questions VI. 15 in the R/G-CAG and questions XII. 73 and XII. 74 in the C-CAG.

Collisions	16 PV only + 12 OV only + 4 both = 32/88
Groundings	99/162
Ramming	98/154

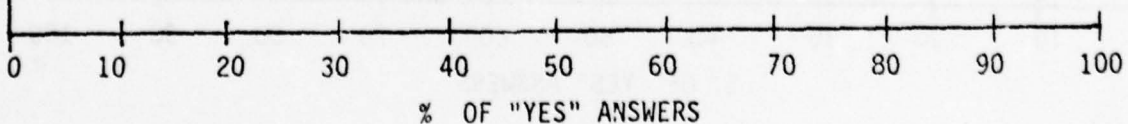


CASUALTY PRECIPITATING FACTORS - CHART 3.39

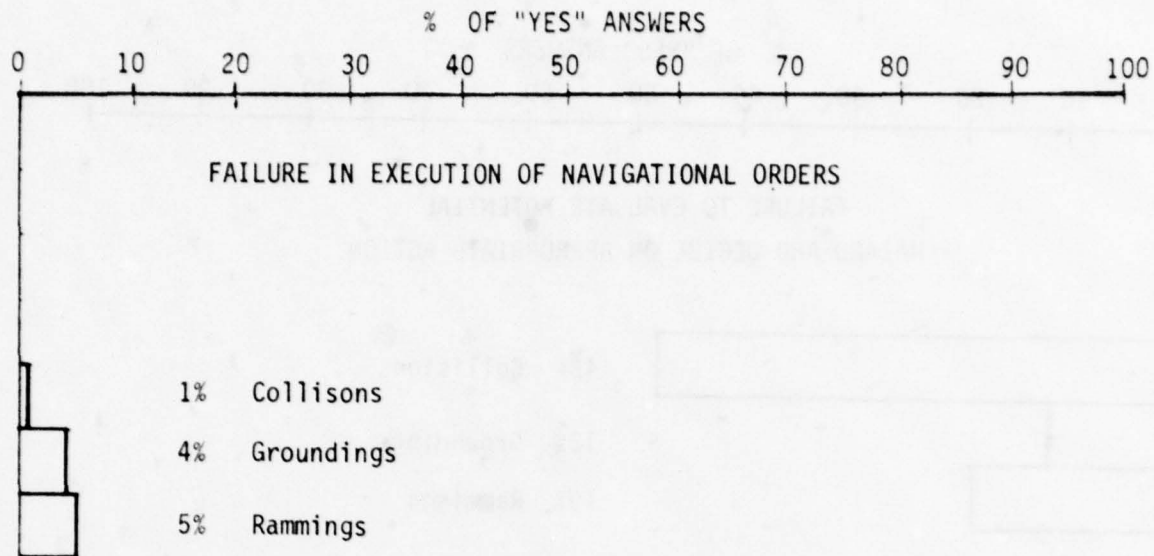


These percentages reflect answers to question VI. 15 in the R/G-CAG and questions XII. 45 and XII. 46 in the C-CAG.

Collisions 11 PV only + 16 OV only + 15 both = 42/88
 Groundings 19/162
 Rammings 30/154

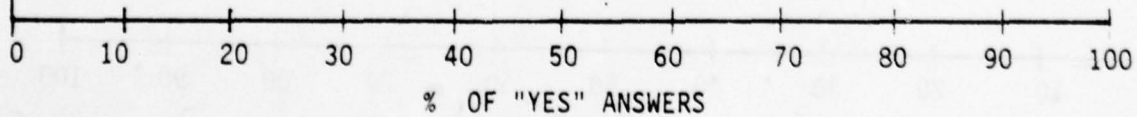


CASUALTY PRECIPITATING FACTORS - CHART 3.40

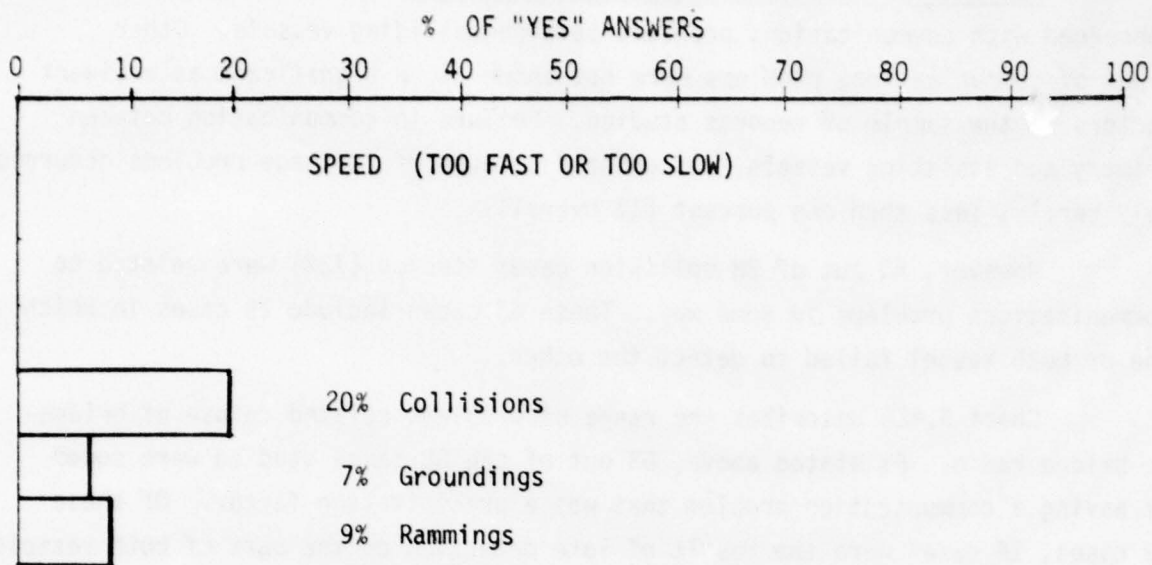


These percentages reflect the answers to question VI. 16 in the R/G-CAG and questions XII. 33 and XII. 34 in the C-CAG.

Collisions	1 OV = 1/88
Groundings	6/162
Rammings	8/154

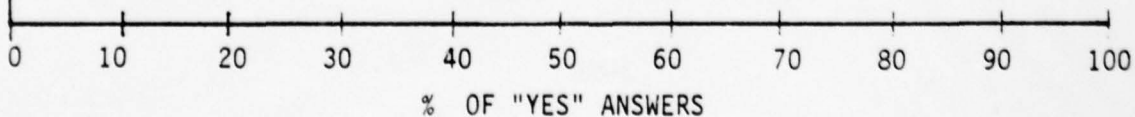


CASUALTY PRECIPITATING FACTORS - CHART 3.41



These percentages reflect answers to question VI. 50 in the R/G-CAG and XIII. 19 in the C-CAG.

Collisions	18/89
Groundings	11/162
Rammings	14/154



Failures in Vessel-to-Vessel Communications. This section is concerned with communications problems between colliding vessels. Other types of communications problems were not shown to be significant as accident factors in the sample of reports studied. Failure in communication between primary and assisting vessels, and onboard because of language problems occurred only rarely, less than one percent (1% overall).

However, 63 out of 88 collision cases studied (72%) were related to communications problems in some way. These 63 cases include 29 cases in which one or both vessel failed to detect the other.

Chart 3.42A describes the range of problems related to use of bridge-to-bridge radio. As stated above, 63 out of the 88 cases studied were coded as having a communication problem that was a precipitating factor. Of these 63 cases, 15 cases were the result of late detection on the part of both vessels. In 38 other cases, communication was not established because:

- (a) Only one party was using its bridge-to-bridge radio (20 cases)
- (b) Neither vessel attempted bridge-to-bridge communication (12 cases)
- (c) Communication was established but was faulty in that imprecise information was provided or the agreed upon passing agreement was inappropriate to the situation (10 cases)
- (d) Both parties used their radio but could not raise the other vessel (6 cases).

Fourteen of the cases in (a) and (b) coincide with late detection on the part of one of the two vessels involved. Figures are given in Section IV concerning how often a vessel attempted to contact the other vessel once it was detected.

In 10 of the 63 cases, voice communication was successfully established between the colliding vessels. The problems in these cases were the result of not providing precise information about each vessel's intentions or on arranging a passing agreement that was inappropriate to the situation. Looking at all the collisions, one can say that passing imprecise or improper information was a precipitating factor in 11% (10 out of 88) of the cases.

CASUALTY PRECIPITATING FACTORS - CHART 3.42A

PROBLEM ARISING IN THE USE OF BRIDGE TO BRIDGE RADIO

This chart demonstrates the use of bridge to bridge radio (b to b) in those 63 collision cases in which a communications problem was sighted as a precipitating factor.

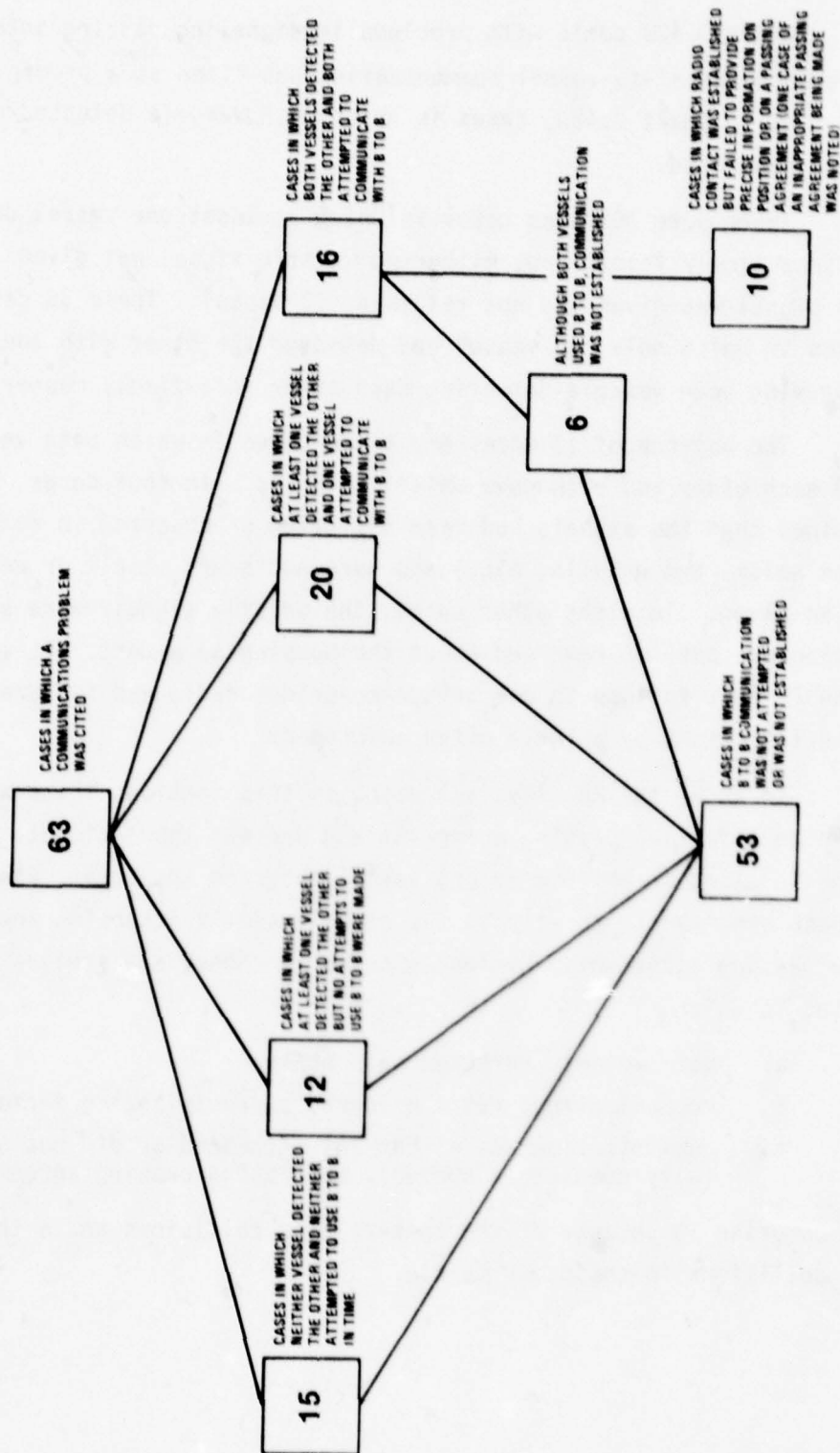


Chart 3.42B deals with problems in signaling passing intentions by whistle when vessel-to-vessel communication was cited as a precipitating factor. As in Chart 3.42A, cases in which both vessels detected each other late are separated.

There were 35 other cases in which at least one vessel detected the other in a timely fashion but either no whistle signal was given (16 cases) or one signal was given and not returned (19 cases). These 35 cases contain 14 cases in which only one vessel had detected the other with the remainder (21) showing both vessels detecting each other in a timely manner.

The balance of 13 cases are those cases in which both vessels detected each other and both gave whistle signals. In four cases, it was determined that the signals had been distorted or obscured in some way (engine noise, own whistle, etc.) and were not heard at all or were not heard as given. In eight other cases, the whistle signals were heard but confusion or conflict remained about the passing agreement. It is shown in Section IV that failure to use bridge-to-bridge radio and failure to signal passing intentions by whistle often coincided.

In 48 of the 88 cases addressed in this section, there was opportunity to make an effective passing agreement and prevent the accident. These 48 include 14 cases in which only one vessel detected the other, where there may have been opportunity to attract the other vessel's attention and then proceed with a passing agreement. Excluding these 14 cases, one arrives at 34 out of 88 cases in which

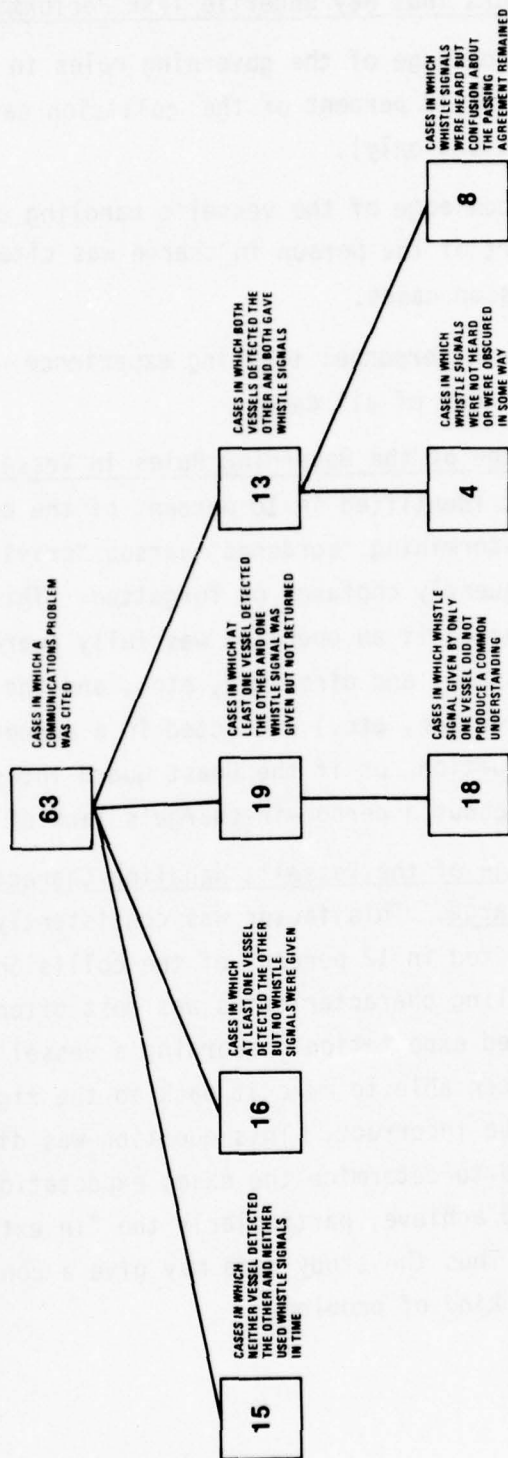
- a. both vessels detected each other
- b. communications was considered a precipitating factor
- c. communication was either not attempted or did not successfully complete a commonly understood passing agreement.

These comprise 39 percent of the task-related collisions and a third of all (103) collisions in the study sample.

CASUALTY PRECIPITATING FACTORS - CHART 3.42B

PROBLEMS ARISING IN THE USE OF WHISTLE SIGNALS

This chart demonstrates the use of whistle signals in those 63 collision cases in which a communications problem was sighted as a precipitating factor.



NOTE: DISCREPANCIES IN THIS CHART ARE THE RESULT OF ERRORS IN CODING THE COLLISION CASES. THE SECTION ON COMMUNICATIONS PROBLEMS (XII 60, 70, XII 72) USED A BRANCHING SCHEME WHICH WAS MISINTERPRETED ON AT LEAST TWO OCCASIONS.

Knowledge/Training Factors That May Underlie Task Performance Problems

- Lack of knowledge of the governing rules in vessel encounters was cited in 10 percent of the collision cases (question asked for collisions only).
- Lack of knowledge of the vessel's handling characteristics on the part of the person in charge was cited in 12 percent of the collision cases.
- Insufficient personnel training experience was found in less than 3 percent of all cases.

Lack of Knowledge of the Governing Rules in Vessel Encounters. This precipitating factor was identified in 10 percent of the collisions studied. The specific rules on determining "burdened" versus "privileged" vessel status were the rules most frequently confused or forgotten. This precipitating factor would only be checked if an operator was fully aware of the situation at hand (his position, speed, and direction, etc., and the other vessel's position, speed, and direction, etc.) and acted in a manner counter to the rules governing that situation, or if the Coast Guard investigating officer made a direct statement about a person-in-charge's lack of knowledge.

Lack of Knowledge of the Vessel's Handling Characteristics on the Part of the Person in Charge. This factor was consistently tied with emergency maneuvering; it was noted in 12 percent of the collision cases. Lack of knowledge of vessel handling characteristics was most often considered to be present when the stated expectation concerning a vessel's responsiveness (e.g., "We should have been able to make it back to the right side of the channel") were shown to be incorrect. This question was difficult to code in that it was often hard to determine the exact expectations about what any particular maneuver would achieve, particularly the "in extremis" maneuvers of a privileged vessel. Thus the study data may give a conservative picture of the incidence of this kind of problem.

Insufficient Personnel Training Experience. This was rarely cited in the accident reports (3% collisions, 2% rammings, 1% groundings) because the information necessary to make such a judgment is seldom available. Insufficient training was typically cited when a person was given responsibilities outside the realm of his usual functions. The positions the untrained person most often assumed were at the helm, at the radar, and deckhand lashing barges together or working on a hawser.

Personnel Involvement in Tasks Not Directly Related to Vessel Control. This problem was a factor in seven of the collision cases (8 percent) the distracting involvement occurred on the "other" vessel, suggesting that this may more likely be a problem on smaller, special purpose vessels. In any case, "task overload" is not demonstrated to be a major problem area by the study data.

Environmental Factors

The next set of questions was asked to gauge the extent to which disruptive environmental factors contributed to the accidents studied.

- Strong current was the most frequent natural environmental factor, cited in 34 percent of the groundings, 40 percent of the rammings, and 11 percent of the collisions (Chart 3.43).
- Strong winds were cited in 20 to 25 percent of the groundings and rammings, respectively (Chart 3.44).
- Tidal conditions were rarely implicated (in no collision, seven groundings, and in only two rammings).
- None of these environmental factors was cited as frequently in collisions as in groundings and rammings.

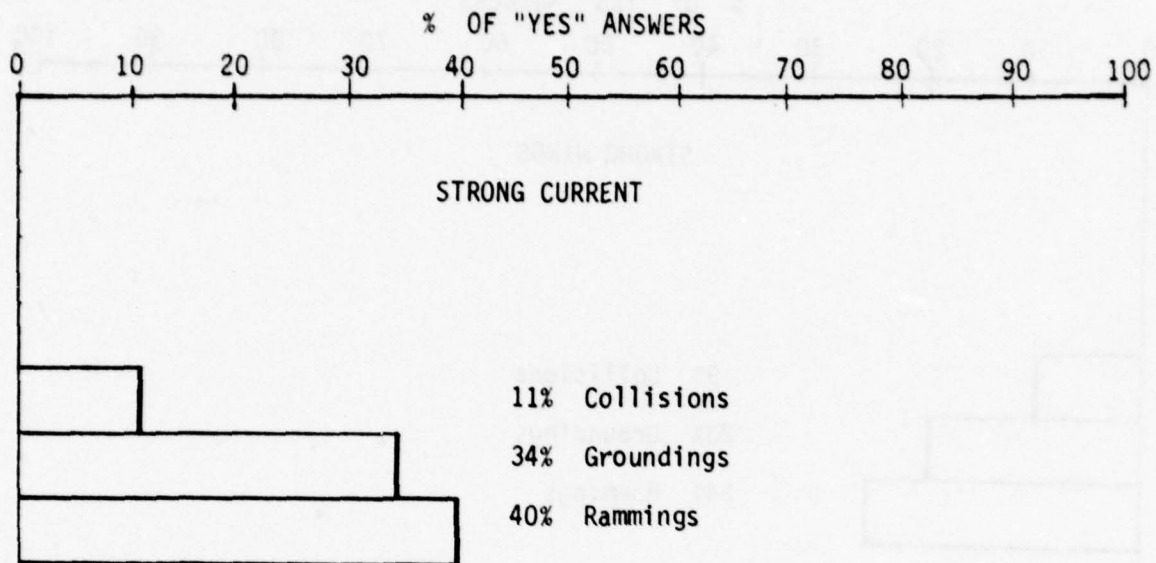
These environmental influences were only checked as causal factors if there was some suggestion given in the accident report that they were important. Even if the wind speed was 40 mph, strong wind was not necessarily a causal factor (although the odds that it was would be good).

Strong Current. Strong current was the most frequently reported environmental force affecting vessel operations. "Strong" is a judgment call in that current magnitudes of as little as half a knot can have strong impact, especially on deep draft vessels, depending on other variables in the situation. The term as interpreted in this study applies to the effect on the vessel rather than to some standard of current speed.

Strong Winds. Although not reported as often as strong current, the relative values of the response rates are very similar. Equivalent decision criteria were applied in deciding if wind was an accident-precipitating factor.

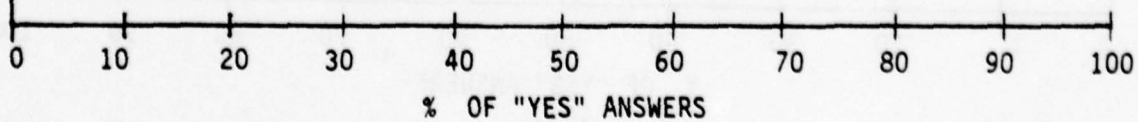
Strong Tidal Conditions. This question was defined to exclude tidal currents in order to emphasize high waves and rough seas. The effects of tidal currents were scored as "strong current" when appropriate.

CASUALTY PRECIPITATING FACTORS - CHART 3.43

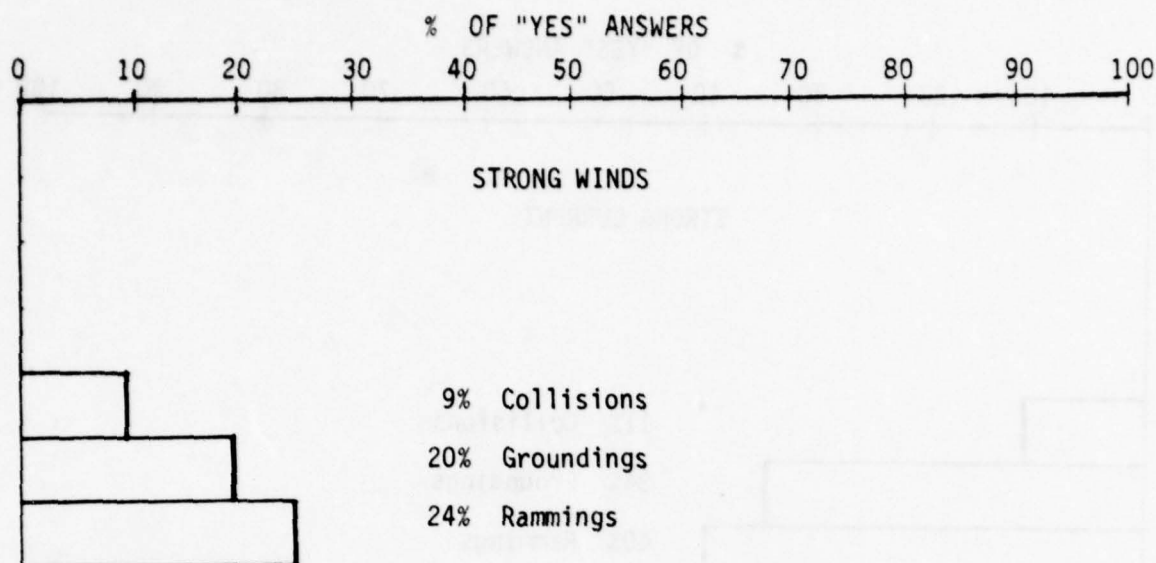


These percentages reflect the answers to question VI. 20 in the R/G-CAG and questions XII. 18 and XII. 19 in the C-CAG.

Collisions	6 PV + 4 OV = 10/88
Groundings	55/162
Rammings	62/154

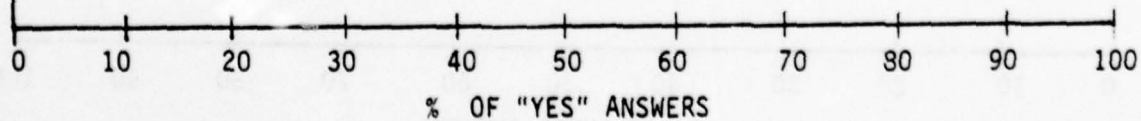


CASUALTY PRECIPITATING FACTORS - CHART 3.44



These percentages reflect the answers to question VI. 21 in the R/G-CAG and questions XII. 20 and XII. 21 in the C-CAG.

Collisions	5 PV + 2 OV + 1 both = 8/88
Groundings	33/162
Rammings	37/154



Impediments to Visual Perception. Charts 3.45 - 3.47 show that . . .

- A greater proportion of collisions (more than twice the proportion) than of either rammings or groundings is associated with an obscuring condition of the environment. This factor is cited in about a third of the collisions studied as compared to about 15 percent of the other two accident types.
- Nine percent of the collisions were related to obstructed vision as a result of ship design or loading characteristics.
- Eleven percent of both collisions and groundings were related to a hazard that was exceptionally difficult to detect (unlighted, submerged, etc.).

Obscuring conditions of the environment as used in this study refer to physical conditions that may affect normal and timely data gathering. The most obvious and most recurrent items in this category are fog and rain. Some other possibilities are snow, blinding lights, heavy sea return, and the presence of a bend in the channel.

Fog was the major problem area in collisions, as indicated by the previous Chart 3.20, showing that 27 percent of the collision cases occurred when visibility was less than a quarter of a mile. Thirteen percent of both the rammings and groundings occurred under this circumstance.

The frequency of fog or otherwise reduced visibility as a collision factor suggests the possibility of problems in the use of radar. The collision CAG asks whether inability to interpret radar was a factor in the casualty, and only five reports (6 percent) explicitly call it out, for six vessels. (In one case the factor was found on both vessels.) This may not be a reliable indicator, since the reports rarely consider the task proficiency of personnel in such detail. The frequency of failure to monitor the position and movement of the other vessel (PV or OV), along with other study findings, suggests that perhaps problems in the use of radar should be examined. Other possible radar problems include non-use, and improper operating condition and/or limited design capability. Sufficient data were obtained to establish only whether the radar was on in most cases. (It was not in 25 percent of the collisions in which a determination could be made.)

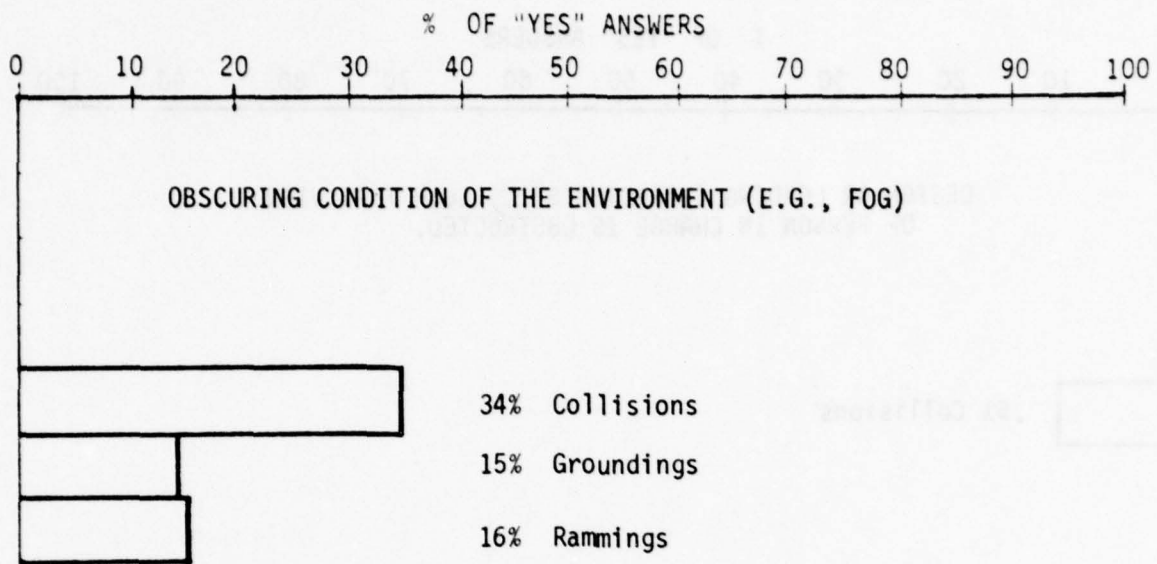
Obstructed View of the Person in Charge Due to Design or Loading Characteristics. This question was asked only in the collision questionnaire; obstructed views were cited as a factor in 16 cases, on 8 vessels. If there was a design of loading impediment to vision from the bridge, it was considered to be a causal factor in the accident even if a lookout was relaying correct information about an approaching hazard. The incidence of impediments to vision in the design or loading of the vessel may be artificially low because the accident reports do not normally consider this possibility.

Failure to Detect Hazard/Aid Due to Its Nature or Condition

Detection was also infrequently found to have been impeded by the nature or condition of the hazard or aid (e.g., low profile, unlighted, submerged). This factor was indicated in 11 percent of both collisions and groundings, and not at all in the rammings.

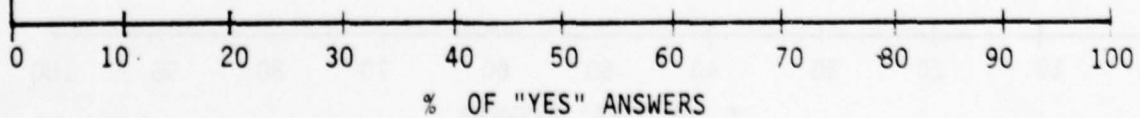
The natures and conditions involved in each accident type are completely different. Collisions were more apt to involve claims that vessels were unlighted, whereas the groundings cases typically involved submerged objects. (Normal shallow water was not considered in the scope of this question.)

CASUALTY PRECIPITATING FACTORS - CHART 3.45

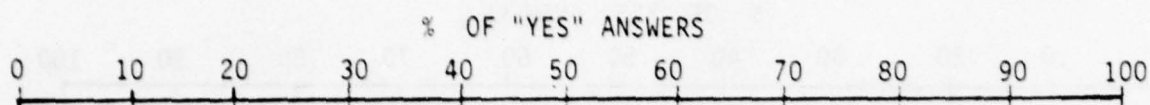


These percentages reflect answers to question VI. 34 in the R/G-CAG and question XII. 43 in the C-CAG.

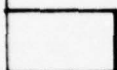
Collisions	30/88
Groundings	25/154
Ramming	22/154



CASUALTY PRECIPITATING FACTORS - CHART 3.46



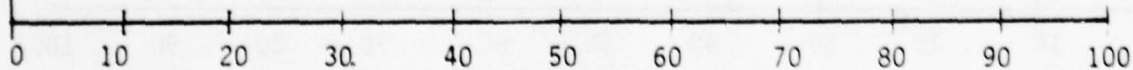
DESIGN OR LOADING CHARACTERISTICS SUCH THAT VIEW
OF PERSON IN CHARGE IS OBSTRUCTED.



9% Collisions

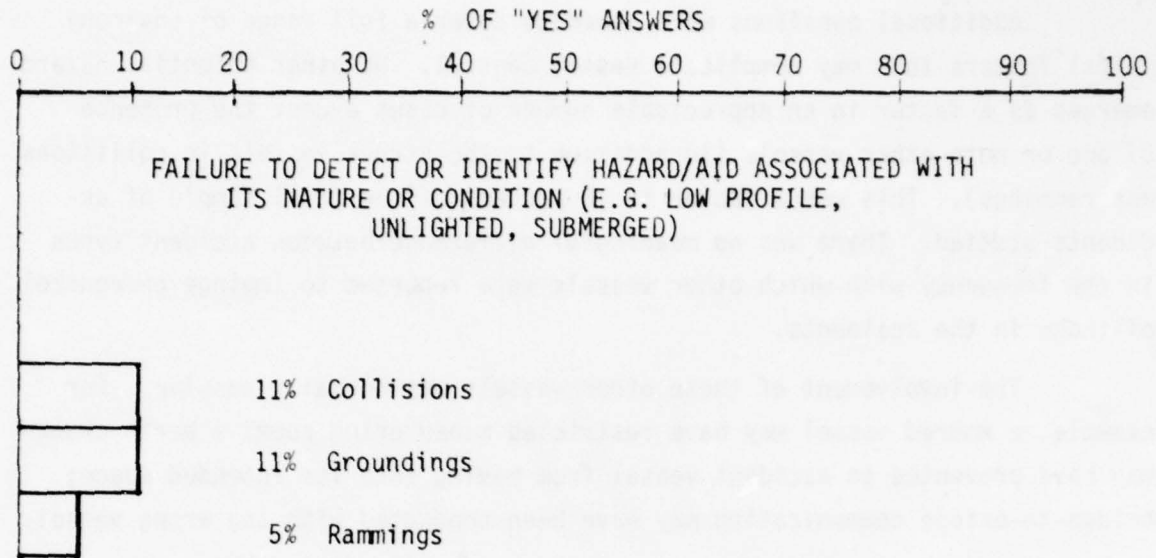
This percentage reflects the answers to questions XII. 41 and
XII. 42 of the C-CAG.

Collisions 6 PV only + 2 OV only = 8/88



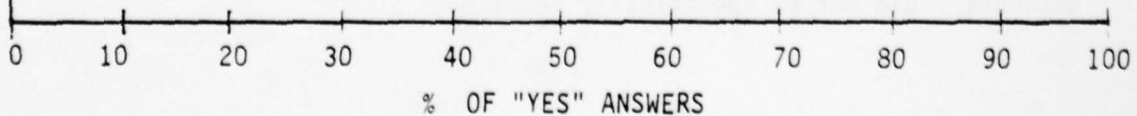
% OF "YES" ANSWERS

CASUALTY PRECIPITATING FACTORS - CHART 3.47



These percentages reflect answers to question VI. 33 in the R/G-CAG and questions XII. 39 and XII. 40 in the C-CAG.

Collision	4 PV only + 6 OV only = 10/88
Grounding	18/162
Ramming	7/154



Other Environmental Factors

Additional questions were asked to cover a full range of environmental factors that may complicate vessel control. No other potential hazard emerged as a factor in an appreciable number of cases except the presence of one or more other vessels (in addition to the struck vessels in collisions and ramblings). This was a factor in 16 percent of the total sample of accidents studied. There was no meaningful difference between accident types in the frequency with which other vessels were reported to impinge on control of those in the accidents.

The involvement of these other vessels was normally passive. For example, a moored vessel may have restricted maneuvering room; a berth change may have prevented an accident vessel from moving into its intended space; bridge-to-bridge communication may have been conducted with the wrong vessel.

Some of the omissions, the non-factors, may be of interest because they have been thought to be important contributors to accidents:

- Only 2 percent of all accidents studied involved a claim or documentation specifying a malfunctioning aid to navigation as a causal factor in the accident.
- Shoaling was a precipitating factor in 7 percent of the groundings.
- Shallow water (normal condition within the prescribed operating area) was cited as a factor in only 2 percent of the groundings.
- Ice was cited in only two cases.²
- Another floating object/debris was cited in only one case.
- A submerged object was a factor in about 5 percent of ramblings and groundings.

² Some 15 ice cases were initially included in the study sample. It was found, however, that they could not be coded because the reports dealt with the damage rather than the accident event sequence. Typically the accident could not be specifically recalled.

These types of potential hazards were not reported to play significant roles in the study sample of cases. However, on this basis alone, it cannot be said conclusively that they are not important as accident factors. Reporting practices may be the reason these potential hazards were not mentioned, or nonrecognition that the information may be relevant.

Other Situational Factors

- 36 percent of the collision cases studied involved at least one vessel being in an unusual location (Chart 3.48).
- 12 percent of the ramblings and seven percent of the groundings and collisions were associated with a complex situation as a precipitating factor (Chart 3.49).
- Deficiency or failure of onboard navigational equipment was found and judged important in 5 percent of the collisions and in 2 percent of the accidents overall (Chart 3.50).
- Inadequate tug assistance was noted in 8 percent of both ramblings and groundings and in 2 percent of the collisions (Chart 3.51). Assisting tugs were infrequently being used by the vessels in collisions.

Vessel in an Unusual or Inappropriate Location. This problem was found in more than a third of the collision cases. As shown in Chart 3.48, it was more often a primary vessel that was considered to have been in an inappropriate location. The "other vessel" category includes the special purpose and small vessels in the collision sample, which might have been expected to be more likely to get out of the channel and into conflict with other oncoming traffic. It would be of interest to cross tabulate this item with vessel type. Reader impressions indicate that this factor was cited for a greater percentage of barge configurations ships over 10,000 GRT.

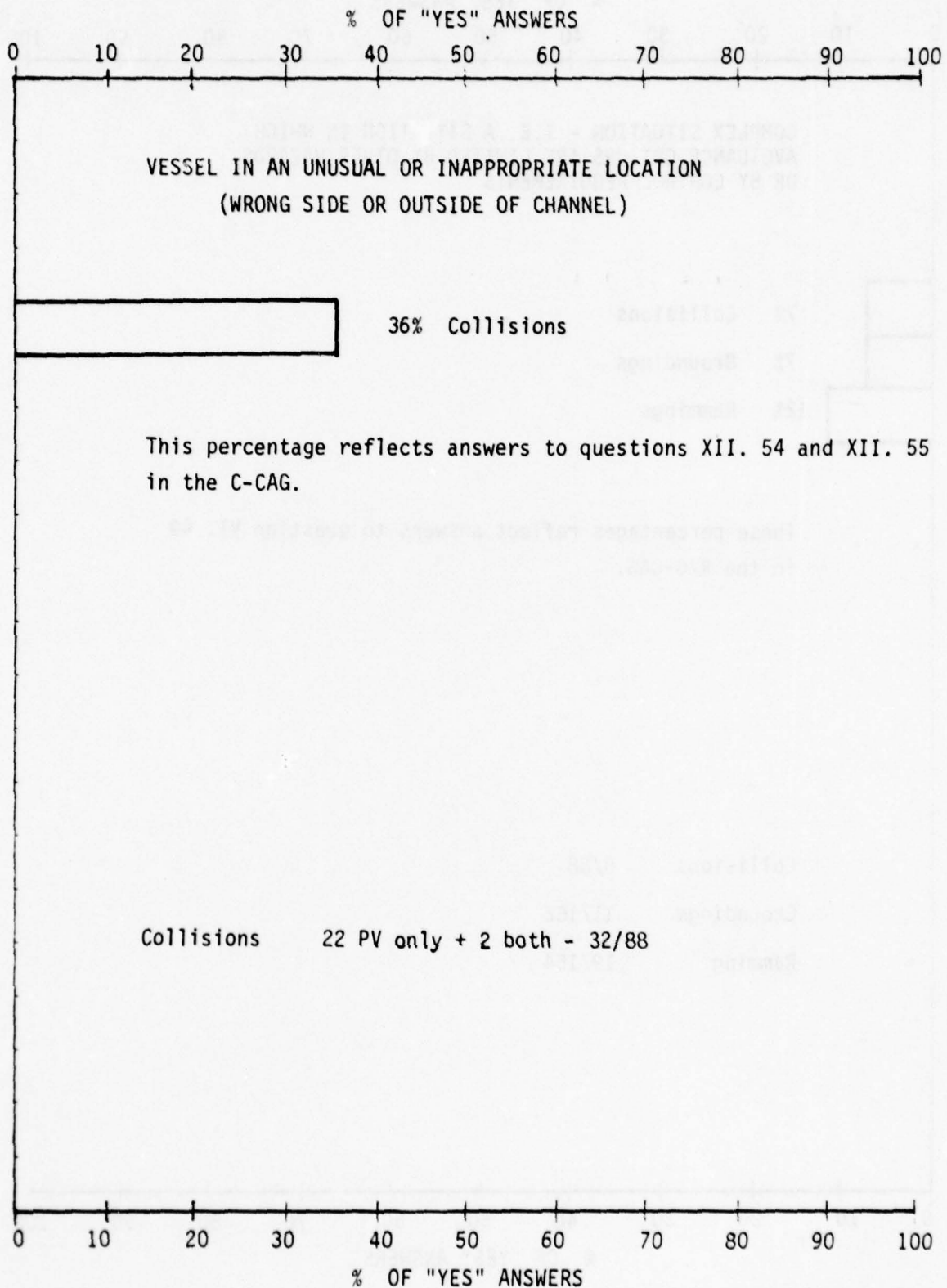
Complex Situation. This type of situation is further described as a situation in which avoidance options are limited beyond normal by special hazards or control requirements. Chart 3.49 shows that 12 percent of the ramblings were related to a complex situation, versus 7 percent of collisions

and groundings. It should be noted that information by which to assess the complexity of the maneuvering situation is scanty in the accident reports. Thus the incidence of this factor may be understated by the results of this study. More information is likely to be provided in the ramming reports because ramming commonly occur during docking/undocking, in tight operations where the relevance of potential complicating factors is obvious.

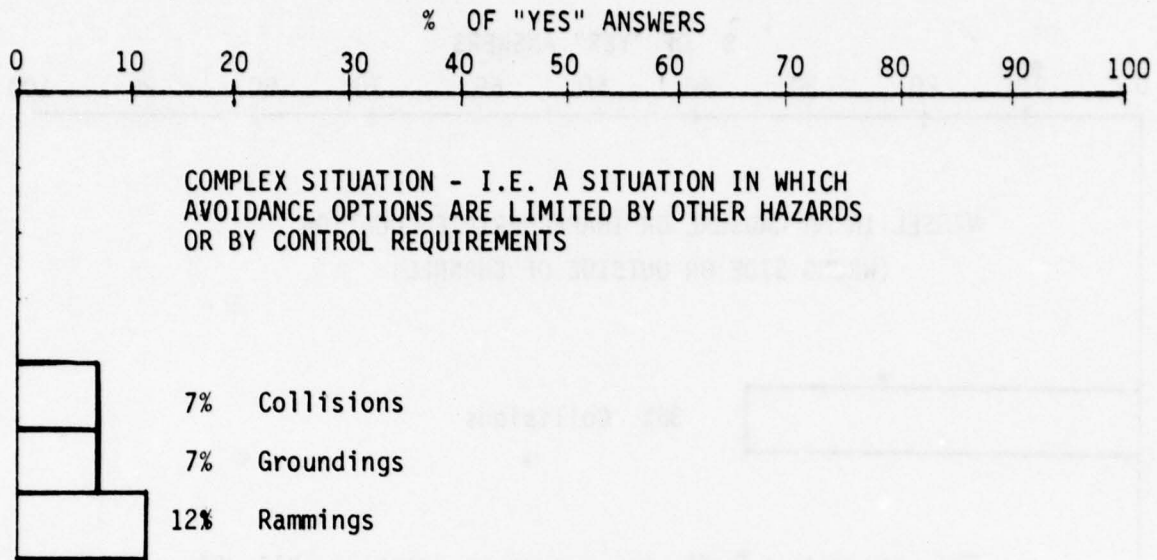
Failure of Onboard Navigational Equipment. The nonresponse rates for questions asked about the operating condition of specific equipment (asked in other sections of the CAGs), reflect the difficulties in answering this question. It is not unlikely that the incidence of navigational equipment failure indicated in Chart 3.50 under-represents the rate of equipment error or nonoperability.

Inadequate Tug Assistance (Chart 3.51). This question was only coded "yes" if a statement directed toward this topic was made in the narratives. Agreement rates on this question were therefore quite high. Either the investigating officer made this determination or the statement of the person in charge was that he could not get tugs or could not get the number he felt was needed.

CASUALTY PRECIPITATING FACTORS - CHART 3.48

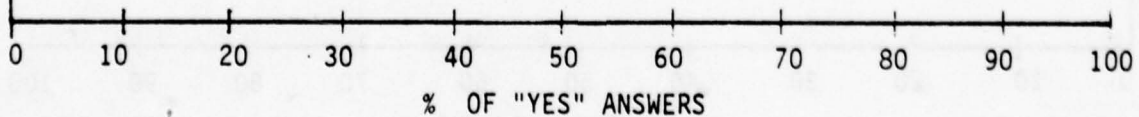


CASUALTY PRECIPITATING FACTORS - CHART 3.49

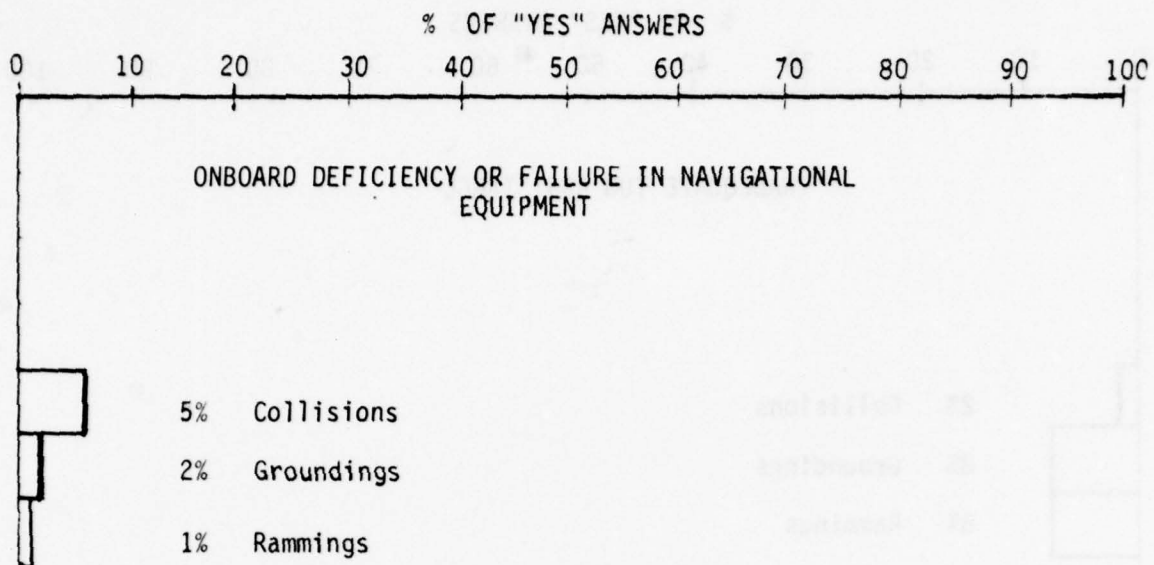


These percentages reflect answers to question VI. 49
in the R/G-CAG.

Collisions	6/88
Groundings	11/162
Ramming	19/154

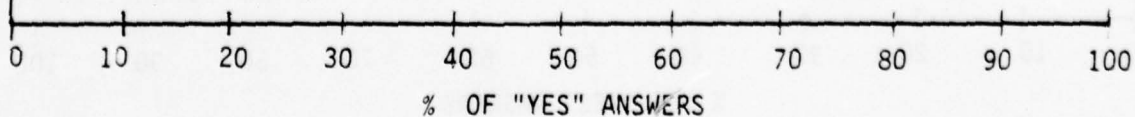


CASUALTY PRECIPITATING FACTORS - CHART 3.50

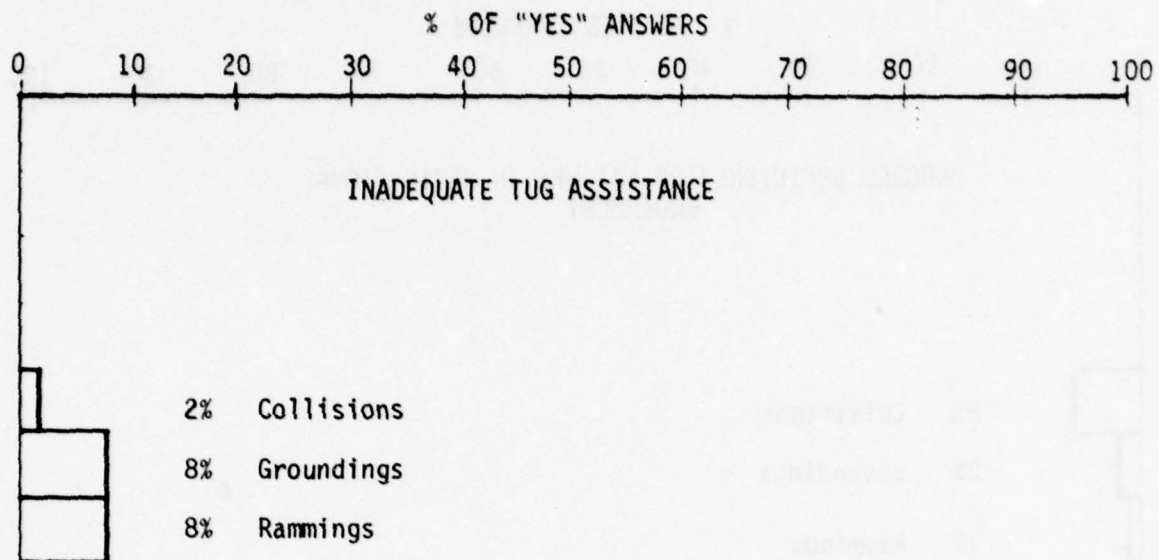


These percentages reflect answers to questions VI. 46 in the R/G-CAG and questions XII. 16 and XII. 17 in the C-CAG.

Collisions	1 PV + 3 OV = 4/88
Groundings	3/162
Rammings	1/154

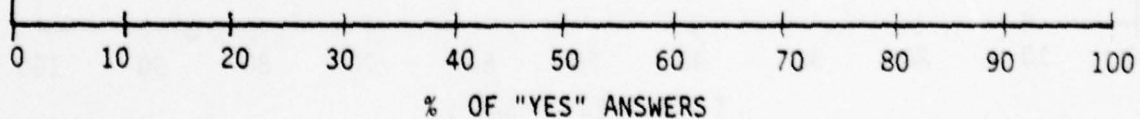


CASUALTY PRECIPITATING FACTORS - CHART 3.51



These percentages reflect the answers to question VI. 51 in the R/G-CAG and XIII. 21 in the C-CAG.

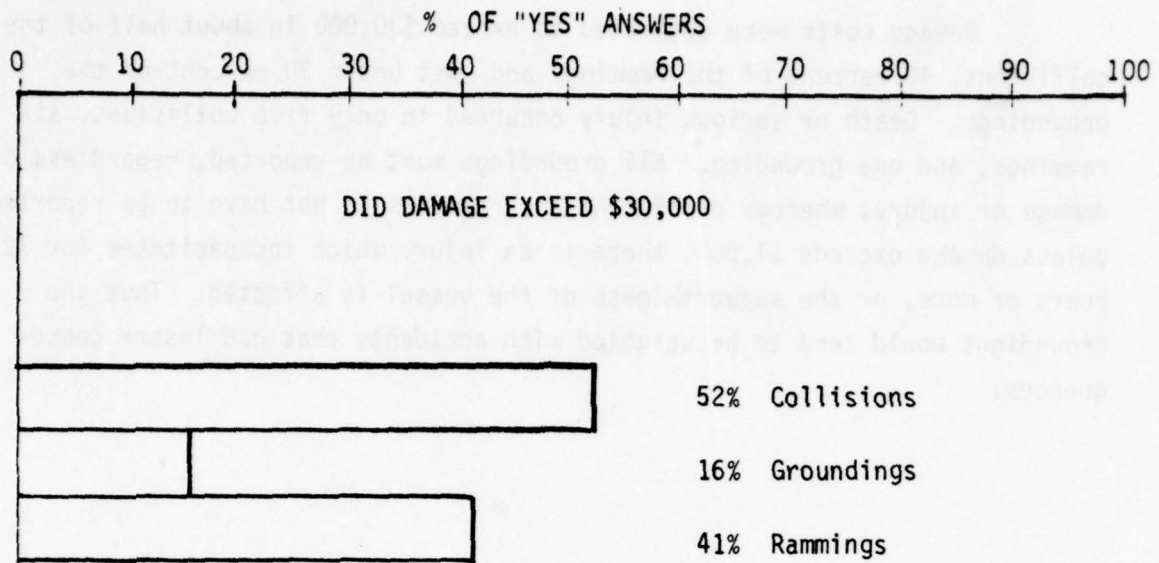
Collisions	2/89
Groundings	13/162
Rammings	12/152



CASUALTY CONSEQUENCES

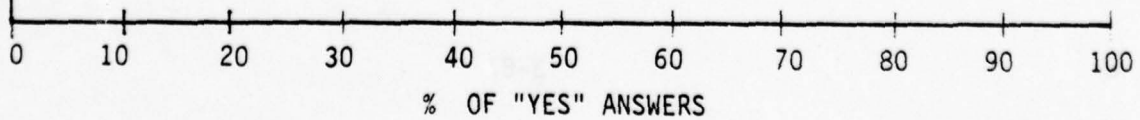
Damage costs were estimated to exceed \$30,000 in about half of the collisions, 40 percent of the rammings and just under 30 percent of the groundings. Death or serious injury occurred in only five collisions, six rammings, and one grounding. All groundings must be reported, regardless of damage or injury, whereas collisions and rammings do not have to be reported unless damage exceeds \$1,500, there is an injury which incapacitates for 72 hours or more, or the seaworthiness of the vessel is affected. Thus the groundings would tend to be weighted with accidents that had lesser consequences.

CASUALTY CONSEQUENCES - CHART 3.52

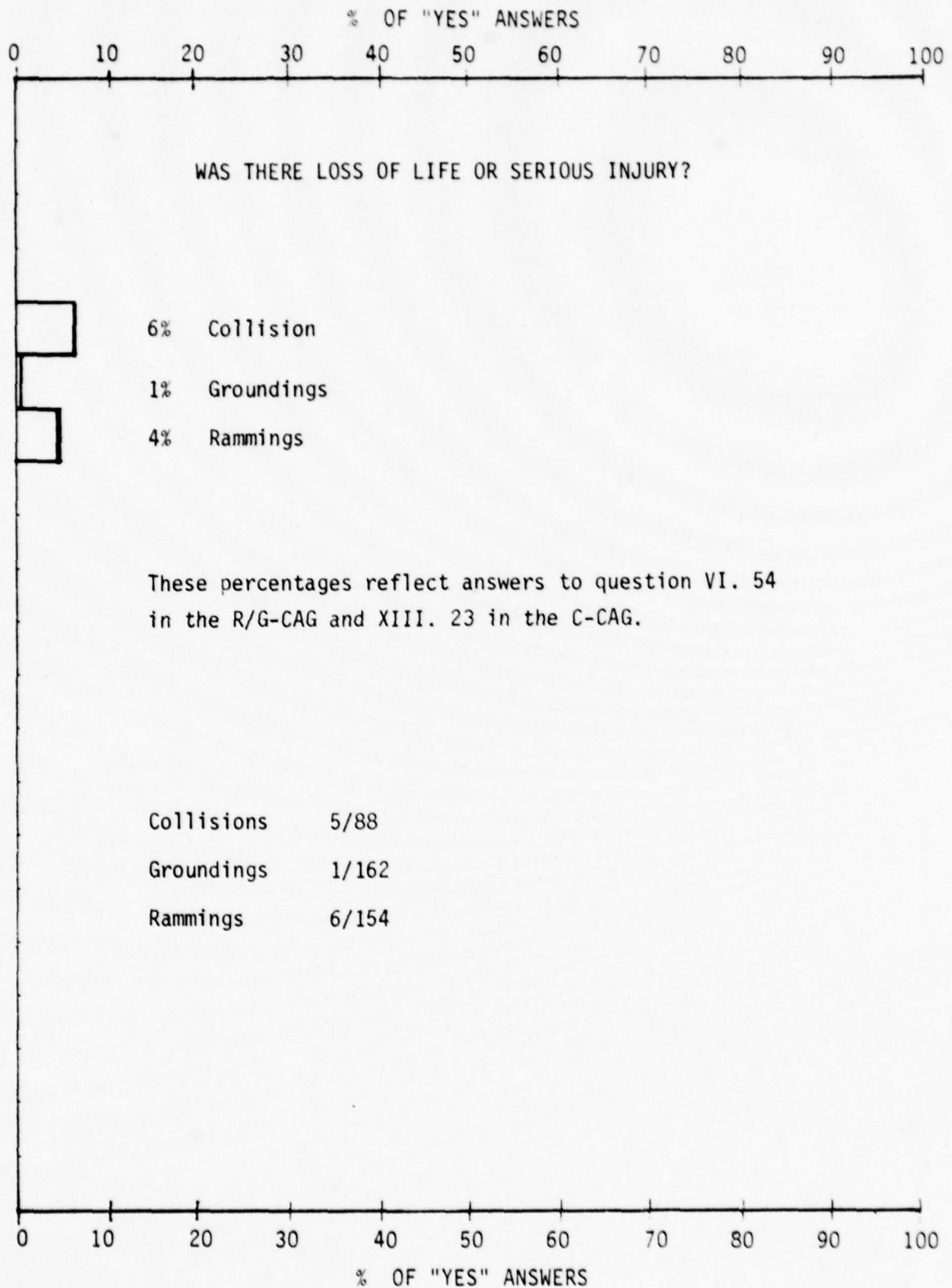


These percentages reflect answers to question VI. 53 in the R/G-CAG and XIII. 22 in the C-CAG.

Collisions	42/81
Groundings	24/151
Rammings	60/146



CASUALTY CONSEQUENCES - CHART 3.53



IV. ANALYSIS OF ACCIDENT FACTOR RELATIONSHIPS

The analysis of the accident reports identified deficiencies or failures in the performance of vessel control tasks in addition to a broad range of situation characteristics. The frequencies which those task problems and situation characteristics were observed in the study sample are presented in Section III. This section examines associations between and within the two categories of variables.

By "association," it is meant, very generally, that there is a pattern in the values taken by one variable in relation to the values taken by one or more others (e.g., peoples' height and weight tend to be linearly associated in a positive way — in general, as height increases or decreases, weight increases or decreases).

The variables used in this part of the harbor accident study have only two possible values, 1 or 0. A variable was either present or absent in the accident case. Variables A and B may tend to be present together, in which case they are positively associated, or A may tend to be present when B is not, a negative association.

The utility of this is that it enables us to describe typical accident scenarios, relating human action and inaction to other conditions with a known degree of confidence.

It is stressed that the measures of association cannot be taken at face value. It is essential to analyze the corresponding tables in light of the CAG design and in relation to other analysis results. Since the variables were cross tabulated and the test of association applied indiscriminately, the results include a substantial number of statistically significant associations that are artifacts of the CAG design or are spurious or uninformative for other reasons. For example, the CAG says not to code failure to properly identify a hazard or aid to navigation as an accident precipitating factor if failure to identify occurred because the hazard or aid was not detected. In such a case, detection failure was coded. This was done because vessel control tasks tend to be a looping sequence. Once one fails, all those which depend upon it fail, and the study aims to isolate seminal problems.

Thus failure to detect and failure to identify are associated with a low probability of error ($\alpha < .0001$). However, the association is negative—when one occurs the other usually does not. Obviously, if a hazard or aid is not detected it will not be properly identified, so the statistical association falsely depicts the real world although it accurately depicts the study data.

There are other reasons for spurious, misleading and uninformative statistical associations in this as in any other study. Thus it is essential to question the statistical results, considering possible biases in the data, and to apply knowledge of the operations or subject area, to evaluate the reasonableness and real significance of the results.

This section treats selected results considered to be of importance. Complete sets of cross tabulations and statistics are provided in seven separately bound volumes.

LIMITATIONS OF THE ANALYSIS

The data base created by analysis of the accident reports is so large that we were unable to treat it fully in this study. The variables treated in this phase of the analysis come from a single part of the Casualty Analysis Gauges (CAGs)—the final part in which task performance failures are classified, along with major categories of situational factors, as

accident-precipitating factors. Earlier parts of the CAGs include more detailed questions about the accident situations and also about task performance. (Unfortunately the latter seldom could be answered from the reports.)

For example, in Section III it is shown that foreign ships are disproportionally involved in collisions. It is further shown that the single most frequent type of task problem in harbor collisions is vessel-to-vessel communications. Another frequent problem is failure to monitor the movement of the other vessel although it was detected. In connection with the latter, an obscuring condition of the environment was a factor in 34 percent of the collisions studied. Without studying the interactions of all of these variables, the problems cannot be clearly sorted out. The task problems and other factors judged to be precipitating factors need to be analyzed in relation to the information on vessel, environment, and other characteristics of the accident situation that are called out in other parts of the CAGs.

PROCEDURES

In view of the resource limits for this study, it was not possible to perform a complete exploratory analysis, even of the results concerning task performance factors. There was not time to unfold the analysis through the classic, iterative processes of analyzing the basic frequency counts of factors, forming tentative hypotheses about possible relationships between factors, computing a set of contingency tables to evaluate those hypotheses, revising and forming new hypotheses, computing additional contingency tables, etc.

Thus we used the computer to create the contingency tables showing the combinations of every pair of task performance factors at once. The same thing was done for all possible groups of three variables that can be formed from the task performance factors in ramming and groundings. In addition, two factors were selected that were very frequently present in the collision cases. They were used as third variables for a limited analysis of three-way interactions of variables in collision cases.

This procedure resulted in a very large amount of output to be analyzed—more than 13,000 contingency tables. To screen the tables, a computer

program was written to extract and rank order statistical measures of the relationships between the combinations of variables. We analyzed the tables only for those variables showing a high degree of statistical association. This is a "number-crunching" kind of procedure, which makes it especially important not to accept a statistical result and apply it without analysis of the relevant tables and CAG questions.

ANALYSIS OF COLLISION PRECIPITATING FACTORS

A complete set of two-variable contingency tables was generated from the data on collision precipitating factors. These are the data elements contained on "cards" XII and XIII of the collision data set. The two-way cross tabulations make up a volume of nearly 1,900 tabulations.

Given the number of variables involved, it is clearly not practical to create a complete set of three-variable contingency tables, or to add additional variables on a wholesale basis. For demonstration, however, two questions were selected for use as third variables for three-way contingency analysis. These questions were selected because they have a relatively high frequency of yes answers as well as no answers. They are: (1) whether an obscuring condition of the environment was involved and (2) whether failure to monitor the position and movement of the threat vessel was involved. The resulting three-way cross tabulations total approximately 7,500 tabulations.

This analysis examines every statistically associated pair of variables that includes at least one task performance variable. Selected three-variable combinations are addressed.

Table 4.1 reviews the task failures identified as collision precipitating factors in the analysis of the accident reports. The factors are listed in order of frequency.

The contingency analysis shows, however, that late detection prepared the way for many of the other task breakdowns. Table 4.2 indicates the role of late detection. The late detection cases are removed from the counts for other task factors as appropriate. The rank order of factors is altered, with communication still first (although by a much smaller margin), failure to establish own position second, and late detection now third in frequency instead of fifth.

TABLE 4.1

RANK ORDER OF TASK PERFORMANCE PROBLEMS IN COLLISIONS

(Problem occurred on one or both vessels. Number of cases = 88; excludes cases in which irrational/irresponsible behavior or equipment failure precipitated the collision.)

<u>Task Problem Area*</u>	<u>No. and % of Cases in Which Problem Was Identified</u>
1. Vessel-to-vessel communication (Question XII.60)	63 (72%)
2. Monitoring position and movement of threat vessel (Questions XII.48, XII.49)	46 (52%)
3. Evaluating navigational situation (Questions XII.45, XII.46)	42 (48%)
4. Maintaining position (Questions XII.73, XII.74)	32 (36%)
5. Late detection (Questions XII.37, XII.38)	29 (33%)
6. Inappropriate speed (Question XIII.19)	18 (20%)
7. Establishing own ship's position (Questions XII.50, XII.51)	16 (18%)
8. Onboard communication problem related to language barrier (Questions XII.56, XII.57)	2 (2%)
9. Executing navigational orders (Questions XII.33, XII.34)	1 (1%)
10. Communication with assisting vessels (Questions XII.58, XII.59)	0

*Please refer to the Casualty Analysis Gauge for collisions, in the appendix, for the exact wording of the questions by which these results were derived.

TABLE 4.2

RANK ORDER OF TASK PERFORMANCE PROBLEMS IN COLLISIONS,
CONTROLLING FOR LATE DETECTION

(Problem occurred on one or both vessels. Number of cases = 88; excludes cases in which irrational/irresponsible behavior or equipment precipitated the collision).

<u>Task Problem*</u>	<u>No. and % of Cases in Which Problem Was Identified</u>
1. Vessel-to-vessel communication (question XII.60) when late detection was <u>not</u> a factor on either vessel	34 (39%)
2. Failure to maintain position (questions XII.73, XII.74)	32 (36%)
3. Late detection (questions XII.37, XII.38)	29 (33%)
4. Speed inappropriate for conditions (question XIII.19)	18 (20%)
5. Monitoring position and movement of threat vessel (questions XII.48, XII.49) where late detection was not a factor	17 (19%)
6. Establishing own ship's position (questions XII.50, XII.51)	16 (18%)
7. Failure to evaluate the navigational situation (questions XII.45, XII.46, where late detection was not a factor)	13 (15%)
8. Onboard communication problem related to language barrier (questions XII.56, XII.57)	2 (2%)
9. Executing navigational orders (questions XII.33, XII.34)	1 (1%)
10. Communication with assisting vessel(s) (questions XII.58, XII.59)	0

*Please refer to the collision CAG, in the appendix, for the exact wording of the questions by which these results were derived.

The most common task problem areas will be discussed in the order in which they are listed in Table 4.2. The collision CAG question numbers are noted in all illustrations, so that the specific question wording can be checked. The question numbers are also cited in the cross tabulations, which are separately bound.

A distinction is made between "primary vessel" (PV) and "other vessel" (OV). The PV's are all ships greater than 10,000 GRT or else tug/towboat-barge configurations. The OV's may be special purpose vessels, fishing vessels, etc. When a collision involved two large ships, a ship and a barge configuration, or two barge configurations, one was arbitrarily designated PV. Chart 3.5, in Section III, shows the combination of vessels.

COMMUNICATION PROBLEMS

The most striking result of the contingency analysis of communications problems is the likelihood that neither vessel made any attempt to communicate by bridge-to-bridge radio equipment (although 87 percent of the vessels in the study sample of collisions had such equipment) or to signal intentions by whistle. When communications was found to be a factor, there was typically an all around failure to try.

Table 4.3 is an example of the contingency table results. It is included here and discussed in some detail to show what was done in the analysis and to make sure the table format is understandable.

TABLE 4.3
FAILURES TO ATTEMPT VOICE COMMUNICATION

Failure on PV? (XII.61) \ Failure on OV? (XII.62)			Row Total
	NO	YES	
NO	16 25%	11 17%	27 43%
YES	9 14%	27 43%	36 57%
Column Total	25 40%	38 60%	63 100%

Chi square = 6.20

Significance = 0.01

*All percentages are of the table total.

In the lower right cell of Table 4.3 it is shown that in 27, or 43 percent, of the cases in which there was some kind of communication problem between the colliding vessels, both vessels failed to attempt voice communication. In 16 of the cases, 25 percent, this was not the problem on either vessel (upper left cell). In 9 cases when the primary vessel did not attempt voice communication, the other vessel did (lower left cell, 14 percent of the Table total). In 11 cases when the primary vessel did not attempt voice communication, the other vessel also did not (upper right cell, 17 percent of the table total). (Percentages of row and column totals are given in the computer-printed tables provided to the Coast Guard with this report.) The row and column percentage are omitted from Table 4.3 to make it easier to read.

Expected values of the cells--i.e., expected cell counts-- can be computed to aid in interpreting the table results. The expected value assumes an even distribution of the possible combinations of answers; the product of the row and column totals applicable to the cell, divided by the total number of cases represented in the table. For example, the expected value, or count, of cases in which both vessels failed to attempt voice communication is lower than the actual count of 27:

$$\frac{38 \times 27}{63} = 16.3$$

That is, failures to attempt voice communication on the two vessels would be expected to coincide by chance less often than they were found to coincide in the study data. Thus a trend is indicated.

The test of statistical association reflects this trend and measures its reliability. The probability of getting a pattern in the distribution of response choices like the one shown in Table 4.3, if the two failures to communicate are unrelated, is 0.01 (the "significance" value shown in the table). Another way of saying this, turning it around, is that the two factors are associated (in this case, the two task failures tend to occur together) with 99 percent confidence.

Table 4.4 summarizes the findings from several tables like Table 4.3. Table 4.4 lists all of the pairs of communications factors that were

found to be positively associated and gives the significance value which indicates the confidence that can be placed in the statistical association. The table is arranged like a correlation matrix. Each row should be read across. For example, reading across the first row, when the PV did not attempt voice communication (bridge-to-bridge radio communications, or "BTBR") it is very likely that the OV also did not, as previously shown in detail in Table 4.3. When the PV did not attempt voice communication it is very likely that the PV did not give a passing signal either (signal passing intentions by sounding the ship's whistle in accordance with the Maritime Rules of the Road). It is also very likely that the OV did not give a passing signal.

There is one instance of "no relationship" shown in Table 4.4. The PV was just as likely to give a passing signal when the OV attempted voice communication as when the OV did not. The significance (α) value of 0.82 indicates a high probability of error in assuming that these task performance failures occur in any pattern in relation to each other.

TABLE 4.4

ASSOCIATIONS BETWEEN COMMUNICATIONS FAILURES
ON THE TWO VESSELS IN COLLISIONS

	<u>OV did not attempt BTBR</u>	<u>PV did not give passing signal</u>	<u>OV did not give passing signal</u>
PV did not attempt BTBR (XII.61)	$\alpha = 0.01$	$\alpha = 0.05$	$\alpha = 0.02$
OV did not attempt BTBR (XII.65)		$\alpha = 0.82$	$\alpha = 0.0005$
PV did not give passing Signal (XII.66)			$\alpha = 0.007$

As previously stated, late detection underlies a substantial number of the communications problems. Late detection by one or both vessels was involved in 46 percent of these communications-related collisions. Late detection by both was involved in 24 percent. These cases must be separated to establish the nature of communications problems as source problems rather than by-products.

Table 4.5 shows that there is no attempt at voice communication in about half of the instances when the threat vessel was detected in time. Primary vessels were somewhat more likely to attempt bridge-to-bridge voice communication when other vessel was detected in time. The difference is probably attributable to the fact that OV group includes vessels not required to carry bridge-to-bridge communication equipment, and operators not likely to be trained in its use as a collision-avoidance aid.

Table 4.5 also shows that a substantially greater proportion of the OV's (60 percent) did not use whistle signals even though the primary vessel was detected. This too is probably attributable to the mix of vessel types in the OV group.

TABLE 4.5

ATTEMPTS AT COMMUNICATION WHEN DETECTION OCCURRED

	<u>Primary Vessel (N=40 cases when OV was detected)</u>	<u>Other Vessel (N=43 cases when PV was detected)</u>
Attempted to establish bridge- to-bridge voice communication	22 (55%)	21 (49%)
Did not attempt to establish bridge-to-bridge voice com- munication	18 (45%)	22 (51%)
Gave passing signal	21 (53%)	17 (40%)
Did not give passing signal	19 (48%)	26 (60%)

COMPARISON WITH FINDINGS IN OTHER STUDIES

An analysis of the effectiveness of bridge-to-bridge radiotelephone was conducted in the Spill-Risk Analysis Program, a precursor of this study.¹ The Spill-Risk analysis used a Casualty Analysis Gauge to classify collisions as to whether or not they could have been prevented by the use of bridge-to-bridge radiotelephone. Then a time series was made on the incidence of potentially preventable accidents over a period of years before and after the introduction of this equipment on commercial vessels.

A substantial decrease in the incidence of potentially preventable accidents was observed during FY 1970 and was credited to the effectiveness of bridge-to-bridge radiotelephone as a collision-avoidance aid. The rate of preventable accidents held stable, FY 1972 through FY 1974, averaging 19 percent of all collisions annually that were judged to have been preventable by the use of bridge-to-bridge radiotelephone versus a pre-device annual average (FY 1965-FY 1969) of 45 percent.

When cases involving detection failure are removed from the communications-related collisions in the sample of accidents used in this study, those cases essentially meet the criteria used in the Spill-Risk study for collisions that might have been prevented by use (effective) of bridge-to-bridge radio communication. As shown in Table 4.2, there were 34 such cases, 33 percent of the total number of collisions studied. This is substantially above the residual of preventable accidents observed as of FY 1974 (average FY 1971-FY 1974) in the Spill-Risk study.

The data are not broken out by year in this analysis. However, the 33 percent of preventable accidents observed here represents a five-year total, FY 1972-FY 1976, that nearly encompasses the period of stable, lower incidence of preventable collisions as observed in the Spill-Risk study.

¹L. Stoehr et al. Spill Risk Analysis Program: Methodology Development and Demonstration, Volume I. Silver Spring, Maryland: Operations Research, Inc., for the U.S. Coast Guard, Office of Research and Development, May 1977. U.S. Coast Guard Report No. CG-D-21-77. NTIS AD A037316.

The difference appears to be attributable to the difference in locations of the accidents in the two studies, and to a related difference in the vessel types. The Spill-Risk study employed a 30 percent sample of all collisions in U.S. waters. This study employed a 20 percent sample of all collisions that occurred in U.S. harbors and coastal areas. In the Spill-Risk study, 80 percent of the collisions occurred on the inland waterways and 12 percent occurred in harbors or coastal areas.

It is believed that this difference points up a significant problem area. Bridge-to-bridge radio communication has been well accepted and implemented by towboat operators on the inland waterways. Conventions for the use of bridge-to-bridge radio are well established. Towboat pilots endorse this equipment heartily and use it routinely to accomplish safe passings. It seems to have been a highly effective safety measure in inland waterway operations, although some collisions still occur that might have been prevented by its use.

The same success is not evident in harbor operations: the equipment is likely not to be used when it could help; the volume and mix of traffic, and vessel identification problems, may make effective bridge-to-bridge communication more difficult; and standard practice for when and how to use the equipment is not clearly defined. Judging from the apparent effectiveness of bridge-to-bridge communication on the inland waterways, there would seem to be excellent potential for similar safety gains in harbor area navigation.

OTHER TASK PROBLEMS ASSOCIATED WITH COMMUNICATION PROBLEMS

Only one other type of task performance problem (other than late detection) is shown to be positively associated with a communication problem. This is failure of the primary vessel to monitor the position and movement of the other vessel. It is associated (96 percent confidence) with communication failure because insufficient or imprecise information was given. No association was indicated between OV failure to monitor PV and imprecise or inadequate information.

These results suggest that the deficient information tended to come from the OV's in the sample. Again the mix of vessels in the OV group is pertinent. It is suggested (a) that the operators of the smaller craft are likely not to be trained in the communication requirements for achieving a successful passing; and (b) when the large vessel does not establish and track the position of the other vessel on its own initiative, a higher than usual collision risk may ensue.

When the primary vessel did not attempt bridge-to-bridge radio communication, failure of the other vessel to maintain position is rarely (one case) a factor. A negative association is indicated ($\alpha = 0.008$). (There is no apparent association between OV failure to attempt bridge-to-bridge radio communication and primary vessel behavior with regard to maintaining position.) This suggests a possible tendency to assume everything is all right, or that collision threat can be avoided by own vessel maneuvering, so long as the other vessel is acting in a steady manner.

ENVIRONMENTAL FACTORS AND COMMUNICATIONS PROBLEMS

Only two environmental factors were found to be associated with communication failure. The analysis showed a positive association between failure to signal intentions by whistle (among vessels in both categories) and the existence of some obscuring condition in the environment. (The significance values are 0.04 for primary vessel and 0.03 for other vessel.) Most often, the obscuring condition was fog, a turn or bend, or weather, in that order. No association was found between failure to attempt bridge-to-bridge voice communication and an obscuring condition of the environment.

The most probable explanation for these results is that when a collision occurs in fog and whistle signals are not used, that omission is most likely to be cited as a precipitating factor because it is a violation of the Rules of the Road, whereas failure to use bridge-to-bridge radio communication is not. It could also be that whistle signals are considered by vessel personnel to be particularly ineffectual when vision is impeded by atmospheric conditions and/or geography.

The other environmental factor is the complexity of the operating situation. The criterion for judging the situation complex was that maneuvering options were limited in some way beyond the normal limitations of channel boundaries. Usually it was the presence of one or more other vessels that made the situation complex.

Complexity of the operating situation, as an accident-precipitating factor, was found to be associated with failure of the PV to attempt bridge to bridge radio communication and also with failure of the OV to signal intentions by whistle. An underlying factor might be preoccupation with the special maneuvering requirements. It also might be some perception of potential confusion or futility in attempting voice communication or a signaled passing agreement under the circumstances.

It is noted that PV's were just as likely not to use whistle signals when the situation was not judged to be complex. The OV's were just as likely not to attempt bridge-to-bridge voice communication whatever the complexity of the situation.

Failure To Maintain Position

Failure to maintain position is the second most frequent task performance factor found in the collision cases (when failure to detect the other vessel is controlled for). This task problem was judged to occur when the vessel left its path of intended movement because of one of the following:

- The vessel was forced off by an environmental condition (including natural forces such as current and the presence of some hazard such as another vessel).
- The person in charge chose the course based on insufficient knowledge of the vessel capabilities/response characteristics so that his intentions could not be accomplished.

Given these decision rules, the trends in variables associated with failure to maintain position are logical outcomes. Considering only two variables at a time, two trends are indicated. Environmental forces and lack of knowledge of vessel handling characteristics are shown to be associated with this type of task problem.

Table 4.6 summarizes the significant relationships between vessel failure to maintain position and other factors. The factor combinations are made by pairing each row item with each column heading. It should be noted that two CAG question numbers are referenced under each column heading. The questions summarized in the headings were asked about both the primary vessel and the other vessel. In the row items, the question is written out separately for the two categories of vessels. In the row that refers to the PV, the column headings should be read as referring to the PV. In the row that refers to the OV, the column headings should be read as referring to the OV.

Table 4.6 includes positive associations, the tendency for both factors to be present or for both to be absent. For example, reading the first cell of the first row in the table, when current is found to have affected the maneuvering of the primary vessel, PV failure to maintain position is very likely to be implicated as a causal factor. This is also true for the OV group, as shown in the first cell of the second row. When wind affected PV maneuvering, it is very likely that PV failure to maintain position is cited (second cell, first row). When lack of knowledge of vessel maneuvering characteristics is cited, failure to maintain position is likely to be cited (fourth cell, both rows).

Finally, when either vessel was found to be in an unusual or inappropriate location at the time of a collision, failure to maintain position on the part of that vessel is very likely to be cited as a factor in the casualty (last cell, both rows).

The lower part of Table 4.6 deals with relationships between the situational factors (the row headings) associated with failure to maintain position. These results point up the two scenarios of failure to maintain position previously discussed: the vessel was forced out of position or the person in charge deliberately directed the vessel into an inappropriate position. Lack of knowledge of vessel maneuvering characteristics is more likely to be found in the latter scenario. Thus the association between current effects and maneuvering knowledge in the PV results does not meet the criterion of statistical significance. (A similar result for wind effects is shown.) This is not true, however, for the OV group. For them, when lack of knowledge is

TABLE 4.6

FACTORS ASSOCIATED WITH FAILURE TO MAINTAIN POSITION
AS A COLLISION-PRECIPIATING FACTOR

	Current Affected Maneuvering (XII.18, 19)	Wind Affected Maneuvering (XII.20, 21)	Other Physical Hazard Affected Maneuvering (XII.32)	Lack of Knowledge of Vessel Maneuvering Characteristics (XII.17, 18)	Vessel in Unusual Location (XII.36, 37)
PV did not maintain position (XII.73)	$\alpha = 0.001$	$\alpha = 0.001$	*	$\alpha = 0.001$	$\alpha = 0.02$
OV did not maintain position (XII.74)	$\alpha = 0.02$	*	$\alpha = 0.001$	$\alpha = 0.002$	$\alpha = 0.01$

	Lack of Knowledge of Vessel Maneuvering Characteristics (XIII.17, 18)
Current Affected Maneuvering, PV (XII.18)	$\alpha = 0.07$
Current Affected Maneuvering, OV (XII.19)	$\alpha = 0.005$
Wind Affected Maneuvering, PV (XII.20)	$\alpha = 0.07$

* No association indicated.

cited, current is likely to be cited. However, the number of cases is small (4 in which current was said to be a factor and 5 in which lack of maneuvering knowledge was said to be a factor. Thus the suggested tendency cannot be given great weight. It could have happened because the operators of small vessels, at least some kinds, are assumed not to be skillful in dealing with current effects, whereas the pilots of the larger commercial vessels are.

Late Detection

Timely detection of the threat vessel is another task that commonly failed on both vessels when a collision occurred. Statistical confidence in concurrence is greater than 99.9.

The frequencies of late detection for the two vessel groups suggest that the primary vessel is key. There are just six collisions in which only the other vessel failed to detect the primary vessel in time:

- Both vessels failed to detect each other, 15 cases
- PV failed to detect OV, 8 cases
- OV failed to detect PV, 6 cases.

Table 4.7 shows the other variables that are significantly associated, in a positive direction, with late detection. The communications factors are omitted since they inevitably follow from late detection and were previously discussed.

As indicated by the table, the study data suggest that when involvement with other tasks is a factor on the other vessel, late detection is very likely to be a factor. (In the study sample there were only five cases in which involvement with other tasks was determined to have contributed to the casualty. This occurred only in the OV group, which includes fishing and other special purpose vessels. In all five cases, late detection was also found to have occurred.)

There is some indication of an association between late detection on the part of the primary vessel and an obscuring condition of the environment (e.g., fog, bend in channel). The significance measure is just beyond the criterion value. A stronger association was expected.

TABLE 4.7
FACTORS ASSOCIATED WITH LATE DETECTION

	Personnel Involved With Other Tasks (XIII.13, 14)*	Obscuring Condition of the Environment a Factor (XII.43)
Late Detection of OV by PV (XII.37)	**	$\alpha = 0.06$
Late Detection of PV by OV (XII.38)	$\alpha = 0.0004$	**

* There were no collisions in which the involvement of PV personnel with other (non-navigational) tasks was said to be a factor.

** No association indicated.

In general the investigation of factors associated with late detection suggests that this kind of task problem stems commonly from inattention or to factors that could not be identified in this analysis. Further analysis should be done to evaluate the role of visibility and other obscuring environmental conditions. The latter were not defined to include darkness and it was not determined in the course of this analysis how often detection failure occurred at night. That should be determined.

Speed Inappropriate for Conditions

Speed was judged to be a factor in 20 percent of the 88 cases considered here (excluding cases attributable to some overriding circumstance) and in 17 percent of all the collisions studied. Considering just two-way cross tabulations, the only factor significantly associated with inappropriate speed is the existence of an obscuring condition of the environment ($\alpha = 0.003$). This result is simply descriptive of the circumstance in which speed is most likely to be cited as a factor in the accident reports. (It was coded as a factor only when the report explicitly said so).

When an obscuring environmental condition was not a factor, an association is seen between "complex situation" and inappropriate speed. Also when an obscuring condition of the environment was not a factor, difficulty in seeing the primary vessel from the other vessel (because of OV design and/or loading) is seen as an accident factor significantly associated with inappropriate speed. These results illustrate what can happen when additional variables are taken into account. A subset of cases may be seen in which there is a relationship between accident factors that does not exist in all cases. The contingency of the relationship is some value of a new variable, not previously considered. When the cases having that characteristic are examined separately, a new pattern is found in the way the original variables combine.

Tables 4.8 and 4.9 illustrate the emergence of a new pattern when a third variable is taken into account. Table 4.8 shows the combinations of the two potential accident factors "complex maneuvering situation" and "excessive speed." Table 4.9 shows the combinations of the same factors when the cases are divided into groups according to whether an obscuring condition of the natural environment was a factor. Tables 4.8 and 4.9 is of interest because, in addition to illustrating the contingencies, they illustrate the importance of examining the tables carefully rather than relying on the statistical indicators.

In Table 4.8, it is shown that a complex maneuvering situation was cited as a factor in only six collisions. This is the most important piece of information in the table. However, for purposes of illustration the topic of frequency is disregarded for the moment. In 67 percent of the cases when the complexity of the maneuvering situation was cited as a factor, inappropriate speed was not cited. In 89 percent of the cases when speed was cited, the complexity of the maneuvering situation was not. This indicates that when one factor was present the other was usually not present, a negative association. However, the most usual case is for neither factor to be present, a contradictory trend. No statistically significant association between these two factors is indicated.

Table 4.9, however, bears out the finding of no association only when an obscuring condition of the environment is a factor. When an obscuring condition is not part of the accident scenario, there appears to be a tendency for "inappropriate speed" and "complex situation" to coincide. First the table arrangement is explained for those who is not familiar with it. Then the content of the table is discussed further.

The computer program used in this analysis, SPSS (Statistical Package for the Social Sciences), computes the combinations of values taken by more than two variables in steps. The third variable is called the control variable. In effect, all cases in which the control variable has the value "a" are drawn from the data set. (In this study the first value of the control variable that is considered is "0," representing a "No" answer to the question. These are

TABLE 4.8
COMPLEXITY OF THE MANEUVERING SITUATION
IN RELATION TO EXCESSIVE SPEED

Complex Maneuvering Situation (XII.47)	Inappropriate Speed Either Vessel? (XIII.19)		
	NO	YES	
NO	66 80%(R) 94%(C) 75%(T)	16 19%(R) 89%(C) 18%(T)	82 93%
YES	4 67%(R) 6%(C) 5%(T)	2 33%(R) 11%(C) 2%(T)	6 7%
	70 80%	18 20%	88 100%

Chi square = 0.08

Significance (α) = 0.77

*(R) Percentage of Row total
(C) Percentage of Column total
(T) Percentage of Table total

TABLE 4.9
FACTORS ASSOCIATED WITH INAPPROPRIATE SPEED
WHEN VISIBILITY IS TAKEN INTO ACCOUNT*

(a) Visibility not a Factor (XII.43)		(b) Visibility a Factor (XII.43)	
Complex Maneuvering Situation (XII.47)	Inappropriate Speed Either Vessel? (XIII.19)	Complex Maneuvering Situation (XII.47)	Inappropriate Speed a Factor, Either Vessel? (XIII.19)
	NO		YES
NO	50 93%(R)+ 96%(C) 86%(T)	NO	16 51%(R) 29%(C) 53%(T)
	4 7%(R) 67%(C) 7%(T)		12 43%(R) 100%(C) 40%(T)
YES	2 50%(R) 4%(C) 3%(T)	YES	2 100%(R) 11%(C) 7%(T)
	52 90%		18 60%
			2 7%
			30 100%

Chi square = 3.42

Significance (α) = 0.06

Chi square = 0.20

Significance (α) = 0.65

+(R) Percentage of row total
(C) Percentage of column total
(T) Percentage of table total

*"Visibility" in the caption refers to any condition of the environment that obscures the ability of vessel personnel to see. Fog is the most prevalent, bend in the channel is next most prevalent. Other such conditions might be shore lights, heavy rain or snow, etc.

the cases in which the factor was not found to be causal in the accident). Then, the values of the other two variables are cross tabulated, for the subset of cases in which the control variable has the value "a". The same thing is done for the subset of cases in which the control variable has the value "b", then "c", and so on until a separate cross tabulation has been made for every value of the control variable. In this analysis, all the variables have only two possible values, 0 or 1, for "No" (not a causal factor), or "Yes" (a causal factor). Thus, two subtables are needed to count all of the combinations of values of three variables. The two subtables in Table 4.9 are labeled (a) and (b). The statistical indicators of association are applicable to the subtables.

Again the low frequency of "Yes" answers is noted and disregarded for the purpose of illustration. Altogether, there were six cases in which a complex maneuvering situation was evident and apparently contributed to the collision. Four of those collisions occurred when an obscuring environmental condition was not found to be a factor--the second row in Table 4.8(a).

Again the typical case is that neither factor was cited (a "No" answer to both questions in 86 percent of the cases). In addition, in 50% of these cases, when "complex situation" was cited, speed also was cited, and in a third of the cases when speed was cited, complex situation also was cited. Thus some tendency is suggested for these two causal factors to occur together (significance of the association = 0.06)

In this example, there were so few cases involving complexity of the maneuvering situation, the results are questionable even though they are shown to be statistically significant. Under the circumstances, the applicability of the test is questionable. However, as previously explained, the contingency tables were generated nonselectively, without preliminary analysis. Thus, it is very important to examine the tables before drawing conclusions about factor relationships.

Frequency notwithstanding, the trend indicated in Table 4.9 is plausible and is believed to be a useful finding. Among the conventions of the accident reporting system, excessive speed in fog is a standard reporting category. It

may be that when this finding is made, the causal inquiry is shut down; other factors that may have been involved are disregarded. It also may be that when visibility is impaired, the presence of other vessels or obstacles to be avoided (the definition of "complex maneuvering situation") are not relevant they might not be seen.

Failure to Monitor the Position and Movement of the Other Vessel

Failure to monitor the position and movement of the other vessel (PV or OV) is typically a mutual failure in the study sample of collisions, just as were detection and communication problems. The association between failure to monitor in the two vessel groups is statistically significant with a probability of error less than 0.0001.

Also as in the detection and communication problem areas, it appears that failure of the PV is more critical. There were 46 total cases in which at least one vessel did not monitor the position and movement of the other:

- 25 both did not
- 12 PV only
- 9 OV only

Another similarity is that, according to the information provided in the accident reports, failure to monitor the other vessel is not associated with any of the external situational factors specified in the portion of the collision CAG that is treated in this analysis. It may be that simple inattention and/or lack of awareness of the potential threat underlie this omission. It may also be that insufficient training in the use of radar as a collision-avoidance aid, inadequate equipment (condition, design capability), or both compound the problem. Since some 60 percent of the collisions occurred at night and about 25 percent when visibility was less than $\frac{1}{4}$ mile, problems related to radar or other collision-avoidance aids are believed to warrant careful examination. Substantially more could be done in that area with the data base created in this study. The area could not be fully explored within the scope of this analysis. It would be helpful to know to what extent the vessels that failed to monitor were those whose radar was not on. It would be helpful to compare the distribution of task problems as causal factors for the vessels of primary interest (large ships and tug/towboat-barge configurations) in collisions at night/twilight or in fog with the distribution for those in all other circumstances. Further comparisons of this kind should be made, classifying vessels by type (at least ship/barge) and registry.

Table 4.10 shows the other task problem areas related to this one. Failure to monitor specifies one kind of evaluation problem, when the threat vessel was perceived but the danger was not recognized or what should be done to avoid the threat was not recognized. It will be shown in the next subsection that this was the major kind of evaluation problem in collisions according to the study sample data. Failure of the primary vessel to establish own position is shown to be associated with its failure to monitor. The questions of inattention/carelessness and skill in using navigational instrumentation, as previously discussed, are raised.

TABLE 4.10

OTHER TASK FACTORS ASSOCIATED WITH FAILURE TO MONITOR
THE POSITION AND MOVEMENT OF THE OTHER VESSEL

	PV Did Not Properly Evaluate (XII.45)	OV Did Not Properly Evaluate (XII.46)	PV Did Not Establish Own Position (XII.50)	Inadequate/Inaccurate Information Given in Communication (XII.65)	Passing Signal Obscured By Onboard Distraction (XII.71)
PV did not monitor (XII.48)	$\alpha = 0.000$	$\alpha = 0.04$	$\alpha = 0.01$	$\alpha = 0.03$	$\alpha = 0.04$
OV did not monitor (XII.49)	$\alpha = 0.002$	$\alpha = 0.0000$			

Incorrect Evaluation of Navigational Situation

Two kinds of evaluation problems are indicated by the study results:

- Evaluation of the threat potential in the upcoming encounter with the other vessel, as evidenced by failure to monitor its position and movement
- Determination of an appropriate course of action when faced with an encounter while out of position (in an "unusual or inappropriate location")

The analysis results reflecting the first of these problems were presented in Table 4.10. The results reflecting the second kind of problem are as follows:

- PV did not properly evaluate navigational situation
x PV in unusual/inappropriate location (XII.54)

$$\alpha = 0.02$$

It is apparent, from the association of failure to monitor the relative position of the other vessel with improper evaluation, that mutual failure to evaluate is characteristic of collision scenarios. The association between failure to evaluate in the PV and OV groups is significant at the 0.009 level.

In the analysis of the problems in monitoring, as well as in communication and detection it was observed that primary vessel performance seems to be more critical. This tendency is not evident in the evaluation problem area:

- 15 cases both evaluated incorrectly
- 11 cases PV only
- 16 cases OV only.

The reasons for this is not clear.

Failure to Establish Navigational Position

As is true of most of the task performance factors in the collision cases, when failure to properly establish navigational position by one vessel was judged to be an accident factor, failure on the other vessel was likely to be cited as well ($\alpha = 0.0005$).

For both vessel categories, being in an unusual or inappropriate location prior to the casualty is shown to be associated with failure to establish position. When an obscuring environmental condition is also cited as an accident factor, the association for the primary vessel is shown to be statistically more significant.

- PV in unusual/inappropriate location (XII.54)
x PV did not establish position (XII.50) $\alpha = 0.07$
- when obscuring condition of environment was a factor (XII.43) $\alpha = 0.0032$
- OV in unusual/inappropriate location (XII.55)
x OV did not establish position (XII.51) $\alpha = 0.0002$
- when obscuring condition of environment was a factor (XII.43) $\alpha = 0.0005$

The above findings were taken from three-factor contingency tables like the one illustrated in Table 4.9. The factors here, however, were more frequently cited as causal.

Establishment of navigational position is a task that is frequently not bothered with on commercial vessels in harbor approach areas. Position-fixing is typically done by eyeball. It is felt that position-fixing is unnecessary and provides untimely information.

Since the task is frequently omitted, it is likely to have been omitted when an accident occurs. In this study, however, a task omission was not necessarily cited as an accident causal factor. Failure to establish position was cited in 18 percent of the collisions (excluding those attributed to overwhelming circumstances).

The association of failure to establish position (as an accident precipitating factor) with being in an unusual or inappropriate location (as a factor) suggests that this task is not so trivial, especially since neither factor is shown to be significantly associated with the presence of another vessel, operation in a complex situation or other variables that might be supposed to intervene. The impact of an obscuring condition of the environment on this association suggest problems in position-fixing by means of radar (since the most common obscuring condition was fog). OV failure to

establish position is separately associated with the existence of an obscuring condition of the environment ($\alpha = 0.05$), in addition to the three-way association.

ANALYSIS OF GROUNDING PRECIPITATING FACTORS

Table 4.11 lists the task performance and situational factors in groundings in order of frequency. Maintaining position is by far the largest task problem area, with detection and identification of hazards and aids to navigation the other major areas. The predominant single situational factor is current, cited in about a third of the cases.

The contingency analysis shows that the typical grounding involves (1) difficulty in determining the force of the current and accurately predicting its effect on vessel position (called an "identification" problem in the study), leading to (2) an insufficient or incorrect control adjustment to compensate for the current, resulting in (3) failure to maintain position and grounding. The same scenario problem pertains when wind is the environmental force to be reckoned with.

Table 4.12 presents the statistically significant positive associations between pairs of task and situational factors ("two-way associations"). In connection with the associations described in the preceding paragraph, it is shown that current and wind are independent - this is not a compound control problem area.

Table 4.12 also shows that evaluation problems typically have to do with a complex operating situation in which maneuvering options are limited, where the complicating factor is commonly one or more other vessels. It might be that another type of accident could have occurred if a grounding had not. Inappropriate speed is another factor in this cluster.

Table 4.12 is presented in the form a correlation matrix. The descriptors of the factors are listed down left side. The same factors are listed across the top, but the descriptors are abbreviated. The descriptors are numbered so that they can be matched more easily. For example, the first value in the table, reading across each row in turn, is the significance of the association between problems in hazard detection and the condition of hazards or aids to navigation.

TABLE 4.11
TASK PERFORMANCE AND SITUATIONAL
FACTORS IN GROUNDINGS

<u>Task Problem Area</u>	<u>No. of Cases in Which Factor was Cited (Total Number of Cases = 162)</u>	<u>% of Cases</u>
Maintaining Position (VI.14*)	99	61%
Identification of Hazard/Aid (VI.12)	59	36%
Detection of Hazard/Aid (VI.11)	53	33%
Establishing Position (VI.13)	20	12%
Evaluating Navigational Situation (VI.15)	19	12%
<u>Situational Factor</u>		
Current (VI.20)	55	34%
Wind (VI.21)	33	20%
Another Vessel Nearby (VI.25)	27	17%
Obscuring Condition of the Natural Environment (VI.34)	25	15%
Equipment Failure (propulsion, steering, towing lines-the means of control) (VI.17)	20	12%

*Refers to question number in the ramblings/groundings Casualty Analysis
Guage contained in the appendix.

TABLE 4.12

TWO-WAY ASSOCIATIONS BETWEEN TASK AND
SITUATIONAL FACTORS IN GROUNDINGS

	2. Condition	3. Identify	4. Maintain	5. Equipment	6. Current	7. Wind	8. Evaluate	9. Vessel	10. Complex	11. Speed
	$\alpha = 0.001$	*	*	*	*	*	*	*	*	*
1. Detection problem (VI.11)										
2. Condition of hazard/ aid made it hard to see (VI.33)		*	*	*	*	*	*	*	*	*
3. Identification problem (VI.12)					$\alpha = 0.001$	$\alpha = 0.000$	$\alpha = 0.03$	*	*	*
4. Failure to maintain position (VI.14)						$\alpha = 0.04$	$\alpha = 0.000$	$\alpha = 0.03$	*	*
5. Equipment failure (VI.17)						*	*	*	*	*
6. Current (VI.20)							*	*	*	*
7. Wind (VI.21)							*	*	*	*
8. Evaluation problem (VI.15)							*	*	*	*
9. Another vessel (VI.25)							*	*	*	*
10. Complex situation (VI.49)										

 $\alpha = 0.03$ $\alpha = 0.002$

*No significant association indicated

Table 4.13 shows the significant associations resulting when three potential factors are considered ("three-way associations"). The table shows the associations between the first two factors listed when the third is not found to be causal (value 0) and when it was found to be causal (value 1). Relationships in addition to those indicated in Table 4.12 emerge. An example of a complete three-factor contingency table was provided in the discussion of collisions (Table 4.9).

When an obscuring condition of the environment is a factor, inappropriate speed and inadequate tug assistance are significantly associated. Controlling for the presence or absence of current as a factor, there is a significant association between inappropriate speed and failure to maintain position and also the complexity of the operating situation. These two sets of associations, considered together, reflect the scenario of getting out of alignment (because of current) on the approach to a bend or in the bend (the obscuring factor). The vessel might have been moving too slowly for the current condition because of the bend or some other factor, or it might have been moving too fast.

Again controlling for current, when current is a factor there is a significant association between failure to establish position and the complexity of the operating situation. This reflects the scenario when there is little margin for course deviation, in a narrow channel with another vessel or some other obstacle limiting maneuvering options.

In general, the major findings of the grounding factor contingency analysis are represented in Table 4.12. Groundings are shown to result from control difficulties developing because of uncertainty about the force and effects of environmental conditions, especially current. It was shown in Section III that current and wind speed were usually not extreme when these accidents occurred, but they were enough, when not properly compensated for, to result in the accident. It appears that groundings may be largely an information problem. They may be a training or technological problem as well, since it is not clear that providing the person in charge with better input about environmental forces and vessel response characteristics would be enough. It may be that training or instrumentation is required to help the person in charge put two elements of information together.

TABLE 4.13
THREE-WAY ASSOCIATIONS OF PRECIPITATING
FACTORS IN GROUNDINGS*

	Statistical Significance (α)	
	0	1
Maintain X Current X Obscuring Condition of Environment**	0.000	0.007
Speed X Tug X Obscuring Condition of Environment	0.66	0.02
Evaluate X Complex X Vessel	0.63	0.02
Vessel X Complex X Current	0.0000	0.55
Vessel X Speed X Current	0.51	0.02
Maintain X Speed X Current	0.03	0.02
Maintain X Vessel X Current	0.86	0.05
Maintain X Complex X Current	0.46	0.05
Establish X Complex X Current	0.93	0.05

*The third variable listed in each set is the control variable. For example, taking the first set of variables, the significance of the association between "maintain" (failure to maintain position) and current is 0.0007 when an obscuring condition of the environment was a factor. The association between first two variables is slightly more significant ($\alpha = 10^{-4}$) when an obscuring condition of the environment was not a factor. "0" is the code used to denote the absence of the factor. "1" is the code used to denote the presence of the variable as a factor in an accident.

**Complete descriptors of these factors and references to the questions in the Casualty Analysis Gauge for groundings, are provided in Table 4.12.

ANALYSIS OF RAMMING PRECIPITATING FACTORS

Table 4.14 lists the task performance and situational factors in rammings in order of frequency. Similar to the groundings, maintaining position is found to be the single largest task problem area. Correct identification of a hazard or aid and evaluation of a navigational situation were second and third in frequency. These frequencies differ from groundings in both rank and magnitude. The major situational factors involved in rammings are the effects of current and wind.

Table 4.15 shows the significant associations between pairs of potential factors in rammings. It is arranged like Table 4.12 for groundings, except that the matrix is incomplete. This was done because a complete matrix would be so large that it would be difficult to present.

Table 4.15 shows detection problems as factors in rammings are significantly associated only with submerged objects, whose condition obviously makes them difficult to discern. This kind of ramming is rare in the accident sample. It does not appear to represent a problem area of major proportion. Similarly, Table 4.15 clarifies the nature of the typical erratic/irresponsible behaviors that precipitated rammings; excessive speed and failure to maintain position (both would have to be extreme to be identified as erratic/irresponsible). However, rammings stemming from erratic/irresponsible behavior are relatively infrequent. Another case of the same kind is failure to execute orders. When this occurred, it was consistently associated with a problem in communication between ship primary and assisting vessels (ship and tug); this is of interest, but it did not occur very often. Likewise, equipment failure obviously led to failure to maintain position, but again this kind of ramming was relatively infrequent. As in the groundings data, "complex situation" is clarified to mean, typically, the presence of one or more other vessels.

The predominant ramming scenario is represented in Table 4.15 by the cluster of associations between failure to maintain position (the most frequent task performance factor in rammings), current, wind, and "another vessel." Identification problems are also shown to be related to current and wind.

TABLE 4.14

TASK PERFORMANCE FACTORS AND
SITUATIONAL FACTORS IN RAMMINGS

<u>Task Problem Area</u>	<u>No. of Cases in Which Factors Was Cited Total No. of Cases - 154</u>	<u>% of Cases</u>
Maintaining Position (VI.14*)	98	64%
Identification of Hazard/Aid (VI.12)	58	38%
Evaluating Navigational Situation (VI.15)	30	19%
Detecting Hazard/Aid (VI.11)	15	10%
Inappropriate Speed (VI.50)	14	9%
Establishing Position (VI.13)	13	8%
<u>Situational Factors</u>		
Fixed Object (VI.28)	86	56%
Current (VI.20)	62	40%
Wind (VI.21)	37	24%
Another Vessel Nearby (VI.25)	22	14%
Obscuring Condition of the Environment (VI.34)	22	14%
Complex Situation (VI.49)	19	12%
Equipment Failure (VI.17)	18	12%

*Refers to question number in the rammings/groundings Casualty Analysis Gauge,
contained in the Appendix.

TABLE 4.15
ASSOCIATIONS BETWEEN TASK AND SITUATIONAL FACTORS IN RAMMINGS

Communication	Submerged Object (VI.27)	Condition of Hazard/Aid (VI.33)	Maintain Position (VI.14)	Evaluation Problem (VI.15)	Erratic Behavior (VI.19)	Inappropriate Speed (VI.50)	Execute Orders (VI.16)	Current (VI.20)	Wind (VI.21)	Another Vessel (VI.34)	Obscured Environment (VI.34)	Equipment Failure (VI.17)	Complex Situation (VI.49)
Detection Problem (VI.11)	$\alpha = 0.000$	$\alpha = 0.0000$	*	*	*	*	*	*	*	*	*	*	*
Submerged Object (VI.27)		$\alpha = 0.0000$	*	*	*	*	*	*	*	*	*	*	*
Identification Problem (VI.12)			$\alpha = 0.000$	*	*	*	*	$\alpha = 0.0000$	$\alpha = 0.0000$	*	*	*	*
Establish Position (VI.13)				*	*	*	*	*	*	*	$\alpha = 0.02$	*	*
Maintain Position (VI.14)				$\alpha = 0.0001$	$\alpha = 0.05$	*	*	$\alpha = 0.0000$	$\alpha = 0.0001$	*	*	$\alpha = 0.008$	*
Evaluation Problem (VI.15)				$\alpha = 0.008$	$\alpha = 0.0000$								
Erratic Behavior (VI.19)					$\alpha = 0.03$		*	*	*	*	*	*	*
Communication Problem (VI.44)							$\alpha = 0.0000$	*	*	*	*	*	*
Current (VI.20)									$\alpha = 0.0009$	$\alpha = 0.0292$	*	*	*
Another Vessel (VI.25)													$\alpha = 0.0001$

Thus the contingency analysis shows that the typical ramming involved (1) difficulty in determining the force of the current and/or wind and accurately predicting its effects on the vessel (called an identification problem), leading to insufficient or incorrect control adjustment to compensate for the current/wind effect while maneuvering in an area with multiple hazards, resulting in (3) failure to maintain intended position, and ramming. The areas of multiple hazards are docks, bridges, and mooring areas where other vessel traffic is common.

This is basically the same scenario as predominates in groundings, except that current and wind are significantly associated in the rammings whereas they are not in the groundings data. The association in rammings is not seen when the effects of a third variable, "fixed object," are controlled for, with the condition that fixed object was not a factor. This suggests that in rammings of moored vessels (the predominant category in addition to rammings of fixed objects, which includes mostly docks and bridges), the combined effects of current and wind were not likely to be part of the problem.

All other statistically significant associations involving three variables were examined. Except for the case described above, they were found to be artifacts of the questionnaire design and coding decision rules, or to provide no new information to substantially modify the basic ramming scenario described above.

With regard to identification problems in rammings, although they are reported here, it is not at all clear that more precise information about environmental forces and vessel response characteristics would help in the highly restricted docking situations. The only real utility of such information would seem to be in deciding whether to attempt the maneuvers at all.

COMMENTS ON THE CONTINGENCY ANALYSIS

The task performance factors should be compared to the more detailed situational factors that are topics in other segments of the Casualty Analysis Gauges. This could not be undertaken because of the large number of variables for which data were obtained. The results presented in this Section, along with those in Section III, can guide further exploration of relationships in the complete data base.

Many more statistically significant relationships than are discussed in this section are listed in the complete sets of computer-printed output from the contingency analysis that was performed. They were all examined. Most were concluded to result from the design of the task-performance part of the questionnaire, or to be of doubtful interest because there was too little variation in the responses (nearly all "yes" or all "no" answers).

The design effects were expected because the task performance questions were written to isolate the initiating problems in a sequence. It was discussed at the beginning of this section that the tasks of vessel control are highly interdependent, so that if one fails, several, and frequently all may fail. Nevertheless, for the study purposes, generally only one or two task problems was coded as a factor, and so there are many strong negative associations between the various task performance factors, the questions had not been designed in this way, virtually all task performance factors would have been coded in many cases, resulting in many strong but uninformative positive associations. Moreover, we would then have no hope of isolating the specific impacts of situational factors because they would tend to be associated with all task performance factors.

With regard to the situational factors that were included in the contingency analysis reported here, they are categories designed to identify situational characteristics about which more specific information was sought in other parts of the CAG's. The categories chosen were those believed essential to make sense out of the task performance factors. Not all of the detailed situational factors could be represented in the task performance part of the questionnaire. Thus the task performance parts of the questionnaires were designed so that they might be analyzed productively, independent of the larger data set. This has been accomplished. The results are of value in themselves, and they also will enable more comprehensive analysis to be performed with greater efficiency than would have been possible otherwise.

STUDY OF TASK PERFORMANCE PROBLEMS
IN REPORTS OF COLLISIONS, RAMMINGS, AND GROUNDINGS
IN HARBORS AND ENTRANCES

APPENDIX:
CASUALTY ANALYSIS GAUGES

MARCH 1979

PREPARED UNDER CONTRACT DOT-CG-41903-A,
TASK ORDER V
FOR THE U.S. COAST GUARD
WASHINGTON, D.C. 20590

HARBOR CASUALTY ANALYSIS GAUGE FOR
COLLISIONS OF SEPARATE UNDERWAY VESSELS

NOTE: The Roman numeral indicates the card number; the Arabic numeral indicates the column number on the coding sheet.

PART I: CASE IDENTIFICATION

I.1-5 Enter the 5-digit case serial number shown on the report.

I.6 Was this casualty a collision of separate, underway vessels?
(Answer NO if it was a collision of a ship with tug(s) assisting that ship or a collision of vessels within a single tug/towboat-barge configuration.)

NO = 0

YES = 1

If answer in column 6 is NO, stop. Identify the nature of the casualty on the file folder and go onto another report.

I.7-8 Enter the numeral 2 in both columns 7 and 8.

I.9 Did this casualty involve a ship of more than 10,000 GRT (moving with or without tug assistance)?

NO = 0

YES = 1

I.10 Did this casualty involve a tug/towboat-barge configuration?

NO = 0

YES = 1

If the answer in both columns 9 and 10 is NO, stop. Identify the nature of the casualty (including vessel type) on the file folder and go onto another report.

I.11-12 Year of casualty (1971 = 71, 1972 = 72, etc.).

I.13-14 Month of casualty (Jan = 01, Feb = 02, etc.).

If the casualty did not occur during the period June 1971 through October 1976, stop. Save the partly completed CAG and go on to another report.

I.15 Type of report.

Marine Board = 1

Narrative = 2

Letter of transmittal = 3
with no significant
data beyond that on
2692

Letter of transmittal = 4
with significant data

PART II: DESCRIPTION OF THE PRIMARY VESSEL

Definition:

- a. The primary vessel is a ship greater than 10,000 GRT (moving with or without tug assistance) or a tug/towboat-barge configuration.
- b. If two such vessels were involved in the casualty, arbitrarily select one as the primary vessel.

In coding columns 16-21, NO DATA is valid only if all of the questions are answered NO DATA. Only one of columns 16-18 may be answered YES.

I.16 Was the primary vessel a tank ship?

NO = 0

YES = 1

NO DATA = 9

I.17 Was the primary vessel a cargo ship?

NO = 0

YES = 1

NO DATA = 9

I.18 Was the primary vessel a passenger ship?

NO = 0

YES = 1

NO DATA = 9

More than one YES may be used in answering questions 19-21 to cover mixed barge arrays. For example, if the array included one or more tank barges and one or more general cargo barges, then both questions 19 and 20 would be answered YES. If that array also included some other kind of barge or one or more unidentified barges, then question 21 would also be answered YES.

I.19 Was the primary vessel a tug/towboat-barge configuration including a tank barge or barges?

NO = 0

YES = 1

NO DATA = 9

I.20 Was the primary vessel a tug/towboat-barge configuration including a general purpose cargo barge or barges?

NO = 0

YES = 1

NO DATA = 9

I.21 Was the primary vessel a tug/towboat-barge configuration including a type of barge not otherwise classified?

NO = 0

YES = 1

NO DATA = 9

I.22 Does the report indicate that this casualty resulted from a sudden failure of propulsion or steering, from a cataclysmic event, or from action on the part of the other vessel such that the primary vessel did not contribute to the casualty occurrence and could not have avoided it?

NO = 0

YES = 1

If the answer to Question 22 is YES, skip to card VI (page 55).

In coding columns 23-25, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for tug/towboat-barge configurations, considering all tugs/towboats as assisting vessels. Answer NA if the primary vessel was a ship operating without tug assistance.

I.23 If the primary vessel was assisted, was there just one assisting vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.24 If the primary vessel was assisted, were there two assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.25 If the primary vessel was assisted, were there three or more assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.26 Were tugs (one or more) standing by?

NO = 0

YES = 1

Code NA in columns 27-43 if the primary vessel was not a tug/towboat-barge configuration. In coding columns 27-31, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.27 If the primary vessel was a tug/towboat-barge configuration, was there just one barge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.28 Were there two or three barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

AD-A071 058

ORI INC SILVER SPRING MD

F/G 13/10

STUDY OF TASK PERFORMANCE PROBLEMS IN REPORTS OF COLLISIONS, RAM--ETC(U)

MAR 79 B PARAMORE, V KEITH, P KING

DOT-CG-41903-A

UNCLASSIFIED

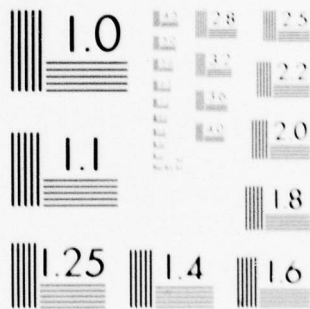
ORI-TR-1474

USCG -D-28-79

NL

3 OF 4
AD
A071058





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

I.29 Were there four or five barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.30 Were there 6 to 10 barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.31 Were there more than 10 barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 32-34, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.32 If the primary vessel was a tug/towboat-barge configuration, was just one barge across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.33 Were there two barges across? (Answer NA if there was just one

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.34 Were there three or more barges across? (Answer NA if there was one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 35-37, NO DATA is valid only if all of the questions are answered NO DATA.

I.35 If the primary vessel was a tug/towboat-barge configuration, was the barge or barge array being pulled at the end of the hawser?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.36 Was the barge or barge array being pushed from astern?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.37 Were tug(s)/towboat(s) alongside?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.38 Was it an integrated tug/towboat-barge configuration?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.39 Was the barge or barge array in a loaded condition?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.40 Was the barge or barge array empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.41 Were some barges loaded and some empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.42 If the primary vessel was a tug/towboat-barge configuration, was its movement a one-man operation (i.e., a single assisting vessel with a single operator)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.43 Was it a Western Rivers type towboat-barge configuration? (NOTE: Tug/towboat pushes from astern. Not integrated. Array size up to 6 x 7.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

Only one of columns 44 and 45 may be coded YES.

I.44 If the primary vessel was a ship, was it carrying cargo?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.45 If the primary vessel was a ship, was it in ballast?

NO = 0

YES = 1

NA = 8

NO DATA = 9

(NOTE: Assume the ship was in ballast, if it was not carrying cargo, unless told otherwise.)

I.46 If the primary vessel was moving with assistance, was it using on-board propulsive units as well? (Answer NA if the primary vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.47 If the primary vessel was moving with assistance, did one or more of the assisting vessel (or vessels) have lateral thrusters or CP propellers? (Answer for the tug(s) or towboat(s) moving barges.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.48 If the primary vessel was moving without assistance, did it have lateral thrusters or CP propellers? (Answer NA if the primary vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 49-51, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.49 If the primary vessel was a ship, was the bridge located forward?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.50 If the primary vessel was a ship, was the bridge located midships?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.51 If the primary vessel was a ship, was the bridge located aft?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 52-54, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.52 The vessel tonnage was 10,000 GRT or less. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

I.53 The vessel tonnage was more than 10,000 GRT to 15,000 GRT. (For barge arrays, take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

I.54 The vessel tonnage was more than 15,000 GRT. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 55-59, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.55 The vessel length was less than 100 feet. (For barge arrays take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.56 The vessel length was 100 feet to less than 300 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.57 The vessel length was 300 feet to less than 500 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.58 The vessel length was 500 feet to less than 700 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.59 The vessel length was 700 feet or more. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 60-62, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.60 If the barge/barge array was being pulled at the end of a hawser, the hawser length was less than 300 feet.

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.61 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 300 feet to less than 600 feet.

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.62 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 600 feet or more.

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 63-66, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.63 The vessel's under keel clearance prior to the casualty was less than 1 foot.

NO = 0

YES = 1

NO DATA = 9

I.64 The vessel's under keel clearance prior to the casualty was 1 foot to less than 2 feet.

NO = 0

YES = 1

NO DATA = 9

I.65 The vessel's under keel clearance prior to the casualty was 2 feet to less than 4 feet.

NO = 0

YES = 1

NO DATA = 9

I.66 The vessel's under keel clearance prior to the casualty was 4 feet or more.

NO = 0

YES = 1

NO DATA = 9

I.67 Did the vessel have just one propeller? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat. Note: on a tug/towboat, the number of engines corresponds to the number of propellers. On a ship there is not necessarily any correspondence.)

NO = 0

YES = 1

NO DATA = 9

I.68 Did the vessel have two propellers? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)

NO = 0

YES = 1

NO DATA = 9

- I.69 Did the vessel have just one rudder? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)
- NO = 0
YES = 1
NO DATA = 9
- I.70 Did the vessel have two rudders? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)
- NO = 0
YES = 1
NO DATA = 9
- I.71 If the vessel was a barge/ barge array under tow, did the tug/towboat have a flanking rudder? (Note: A tug/towboat may have a flanking rudder only; i.e., having a flanking rudder does not necessarily mean the vessel has two rudders.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- I.72 Was the rudder capable of going 35 deg. on either side of midships? (If the primary vessel was a barge/ barge array under tow, answer for the tug/towboat.)
- NO = 0
YES = 1
NO DATA = 9
- I.73 Was the rudder capable of going more than 35 deg. on either side of midships? (If the primary vessel was a barge/ barge array under tow, answer for the tug/towboat.)
- NO = 0
YES = 1
NO DATA = 9
- I.74 If the vessel was a ship, was there bridge control of the main propulsion system?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

I.75 If the vessel was a ship, was the main propulsion system steam?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.76 If the vessel was a ship, was the main propulsion system diesel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.77 If the vessel was a ship, was the main propulsion system gas turbine

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.80 ENTER "1" IN COLUMN 80. THIS COMPLETES CARD I.

The following questions will be answered on Card II.

II.1-10 Duplicate the responses given on Card I, Columns 1 through 10.

II.11 Was the primary vessel a U.S. vessel?

NO = 0

YES = 1

NO DATA = 9

II.12 Was the primary vessel foreign registered?

NO = 0

YES = 1

NO DATA = 9

II.13 Was the primary vessel inspected by the U.S. Coast Guard?

NO = 0

YES = 1

NO DATA = 9

II.14 Was the primary vessel displaying proper lights or other signals as required under the operating conditions? (Answer YES unless the report states otherwise.)

NO = 0

YES = 1

II.15 Was the primary vessel sounding proper signals as required under the operating conditions? (Assume YES unless the report states otherwise.)

NO = 0

YES = 1

II.16 If the primary vessel was not displaying and/or sounding proper signals, were they operative/available?

NO = 0

YES = 1

NA = 8

NO DATA = 9

SKIP COLUMNS II.17 - II. 51. Leave blank.

PART.III: VARIABLE ENVIRONMENTAL CONDITIONS

In coding columns 52-56, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- II.52 At the time of the casualty, visibility was less than $\frac{1}{4}$ mile.
NO = 0 (Answer YES, if the report says dense fog,
YES = 1 heavy fog.)
NO DATA = 9
- II.53 Visibility was $\frac{1}{4}$ to less than $\frac{1}{2}$ mile.
NO = 0
YES = 1
NO DATA = 9
- II.54 Visibility was $\frac{1}{2}$ to less than 1 mile.
NO = 0
YES = 1
NO DATA = 9
- II.55 Visibility was 1 to 2 miles.
NO = 0
YES = 1
NO DATA = 9
- II.56 Visibility was greater than 2 miles.(Answer YES, if the report says
unlimited or clear.)
NO = 0
YES = 1
NO DATA = 9

II.57 Did the vessel(s) encounter a sudden change in visibility shortly before the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

In coding columns 58-63, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.58 At the time of the casualty, the wind was 0 to 3 knots.

NO = 0

(Answer YES, if the report says the wind was calm.)

YES = 1

NO DATA = 9

II.59 The wind speed was 4 to 10 knots.

NO = 0

YES = 1

NO DATA = 9

II.60 The wind speed was 11 to 16 knots.

NO = 0

YES = 1

NO DATA = 9

II.61 The wind speed was 17 to 27 knots.

NO = 0

YES = 1

NO DATA = 9

II.62 The wind speed was 28 to 40 knots.

NO = 0

YES = 1

NO DATA = 9

II.63 The wind speed was greater than 40 knots.

NO = 0

YES = 1

NO DATA = 9

In coding columns 64-68, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for primary vessel.

II.64 The wind direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.65 The wind direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.66 The wind direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

II.67 The wind direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

II.68 The wind direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

In coding columns 69-73, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.69 At the time of the casualty, the sea was calm (0-4 foot swell).

NO = 0

YES = 1

NO DATA = 9

II.70 The sea swell was 5 to 15 feet.

NO = 0

YES = 1

NO DATA = 9

II.71 The sea swell was 16 to 20 feet.

NO = 0

YES = 1

NO DATA = 9

II.72 The sea swell was 21 to 40 feet.

NO = 0

YES = 1

NO DATA = 9

II.73 The sea swell was greater than 40 feet.

NO = 0

YES = 1

NO DATA = 9

In coding columns 74-78, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for the primary vessel.

II.74 The wave direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.75 The wave direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.76 The wave direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

II.77 The wave direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

II.78 The wave direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

II.80 ENTER "2" IN COLUMN 80. THIS COMPLETES CARD II.

The following questions will be answered on Card III.

III.1-10 Duplicate the responses given on Card I, Columns 1 through 10.

In coding columns 11-13, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.11 At the time of the casualty, the current speed was less than 1 knot.

NO = 0

YES = 1

NO DATA = 9

III.12 The current speed was 1 to 2 knots.

NO = 0

YES = 1

NO DATA = 9

III.13 The current speed was greater than 2 knots.

NO = 0

YES = 1

NO DATA = 9

In coding columns 14-18, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for the primary vessel.

III.14 The current direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

- III.15 The current direction relative to ship's center line was parallel against ship's direction.
- NO = 0
YES = 1
NO DATA = 9
- III.16 The current direction relative to ship's center line was perpendicular.
- NO = 0
YES = 1
NO DATA = 9
- III.17 The current direction was broad on bow.
- NO = 0
YES = 1
NO DATA = 9
- III.18 The current direction was broad on quarter.
- NO = 0
YES = 1
NO DATA = 9

In coding columns 19-22, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- III.19 At the time of the casualty, the tidal condition was high water (slack).
- NO = 0
YES = 1
NO DATA = 9
- III.20 The tidal condition was low water (slack).
- NO = 0
YES = 1
NO DATA = 9
- III.21 The tide was flooding.
- NO = 0
YES = 1
NO DATA = 9

III.22 The tide was ebbing.

NO = 0

YES = 1

NO DATA = 9

III.23 Did the vessel(s) encounter a sudden change in wind, current, and/or tide action shortly before the casualty? Answer for the primary vessel.

NO = 0

YES = 1

NO DATA = 9

In coding columns 24-26, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.24 The casualty occurred during the day.

NO = 0

YES = 1

NO DATA = 9

III.25 The casualty occurred at night.

NO = 0

YES = 1

NO DATA = 9

III.26 The casualty occurred at twilight (dawn or dusk).

NO = 0

YES = 1

NO DATA = 9

PART IV: GEOPHYSICAL AND OTHER AREA CHARACTERISTICS

In coding columns 27-30, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.27 Did the casualty occur in a fairly smooth (straight) deep draft channel?

NO = 0

YES = 1

NO DATA = 9

III.28 Did the casualty occur in a channel in which a course change is required?

NO = 0

YES = 1

NO DATA = 9

III.29 Did the casualty occur in a channel in which multiple course changes were required?

NO = 0

YES = 1

NO DATA = 9

III.30 Did the casualty occur in an area essentially unrestricted (in terms of geophysical boundaries), e.g., in a broad open bay, harbor, sound?

NO = 0

YES = 1

NO DATA = 9

(Note: Consider a general anchorage an unrestricted area. Consider a docking/berthing area a restricted area.)

In coding columns 31-35, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.31 In the area of the casualty, the channel width was less than 2 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.32 The channel width was 2 to 3 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.33 The channel width was between 3 and 4 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.34 The channel width was more than 4 times the primary vessel beam.
(Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.35 If the casualty occurred in a deep draft channel, were there channel banks? (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 36-39, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.36 The casualty occurred in a one-way, controlled channel.

NO = 0

YES = 1

NO DATA = 9

III.37 In the area where the casualty occurred, there was only parallel traffic (i.e., meetings and overtakings).

NO = 0

YES = 1

NO DATA = 9

III.38 In the area where the casualty occurred, there was crossing traffic, but limited to one or a few specific locations.

NO = 0

YES = 1

NO DATA = 9

III.39 In the area where the casualty occurred, the traffic pattern was random.

NO = 0

YES = 1

NO DATA = 9

In coding columns 40-43, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- III.40 The casualty occurred when no vessel was in the vicinity other than the vessels involved in the collision?
NO = 0
YES = 1
NO DATA = 9
- III.41 The casualty occurred when there was no other vessel in the vicinity.
NO = 0
YES = 1
NO DATA = 9
- III.42 The casualty occurred when there were two to five other vessels in the vicinity.
NO = 0
YES = 1
NO DATA = 9
- III.43 The casualty occurred when there were more than five other vessels in the vicinity.
NO = 0
YES = 1
NA = 8
NO DATA = 9
- III.44 Was one or more of the vessels in the vicinity underway (excluding those which collided)?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- III.45 Was one or more of the vessels in the vicinity (excluding those which collided) perceived as a hazard by the person in charge of either of the colliding vessels?
NO = 0
YES = 1
NA = 8
NO DATA = 9

III.46 At the time of the casualty, there were recreational boats in the vicinity. (Answer NA if the casualty occurred in a one-way, controlled channel.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.47 At the time of the casualty, there were commercial fishing vessels in the vicinity. (Answer NA if the casualty occurred in a one-way, controlled channel.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.48 Was there LORAN, DECCA, or OMEGA service in the area?

NO = 0

YES = 1

NO DATA = 9

PART V: SCENARIO OF PRIMARY VESSEL OPERATIONS PRIOR TO THE CASUALTY

In coding columns 50-56, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES.

SKIP COLUMN 49. LEAVE BLANK.

III.50 Was the primary vessel in the process of anchoring or disengaging anchor?

NO = 0

YES = 1

NO DATA = 9

III.51 Was the primary vessel in the process of mooring/unmooring or docking/undocking?

NO = 0

YES = 1

NO DATA = 9

III.52 Was the primary vessel just passing by (not entering or exiting a port)?

NO = 0

YES = 1

NO DATA = 9

III.53 Was the primary vessel inbound?

NO = 0

YES = 1

NO DATA = 9

III.54 Was the primary vessel outbound?

NO = 0

YES = 1

NO DATA = 9

III.55 Was the primary vessel passing through port?

NO = 0

YES = 1

NO DATA = 9

III.56 Was the primary vessel making an intra-port move?

NO = 0

YES = 1

NO DATA = 9

III.57 Was the vessel negotiating or close approaching a bridge or lock when the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

III.58 If the vessel was negotiating or close approaching a bridge, was it a drawbridge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.59 Was the vessel negotiating or close approaching a sharp turn (more than 20 deg.) when the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

III.60 If the vessel was a tug/towboat-barge configuration, had it been intentionally set aground just prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.61 Had there been a delay of 2 hours or more in the scheduled movement of the vessel?

NO = 0

YES = 1

NO DATA = 9

PART VI: DESCRIPTION OF BRIDGE PERSONNEL ON THE PRIMARY VESSEL

III.62 Did the person directing vessel handling operations have a federal pilot's license?

NO = 0

YES = 1

NO DATA = 9

III.63 Did the person directing vessel handling operations have a state pilot's license?

NO = 0

YES = 1

NO DATA = 9

III.64 Did the person directing vessel handling operations have some other kind of license pertinent to vessel handling?

NO = 0

YES = 1

NO DATA = 9

III.65 Was the person directing vessel handling operations a special, consulting pilot (not among the regular vessel personnel; someone who comes aboard to guide the vessel in the port area)?

NO = 0

YES = 1

NO DATA = 9

III.66 Was the person directing vessel handling a docking pilot (a specialist in directing docking/mooring maneuvers)?

NO = 0

YES = 1

NO DATA = 9

III.67 Did the special consulting pilot and any assisting vessel(s) come from a common organization? (Answer NA if there were no assisting vessels and/or no special, consulting pilot.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

- III.68 Was the master directing vessel handling operations?
- NO = 0
YES = 1
NO DATA = 9
- III.69 Was the mate on watch directing vessel handling operations? (Include "pilot" of a tug/towboat; this pilot is among the regular tug/towboat personnel and is second in command to the master/captain).
- NO = 0
YES = 1
NO DATA = 9
- III.70 Was someone else directing vessel handling operations?
- NO = 0
YES = 1
NO DATA = 9
- III.71 If a special, consulting pilot was directing the vessel handling operations, was the master present?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- III.72 If a special, consulting pilot was directing vessel handling operations, did the master take over?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- III.73 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a land pilot station or the home office?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

III.74 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a pilot boat?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.75 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.76 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8 to 16-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.77 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 17 to 24-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.80 ENTER "3" IN COLUMN 80. THIS COMPLETES CARD III.

The following questions will be answered on Card IV.

IV.1-10 Duplicate the responses given on Card I, Columns 1 through 10.

For the following questions to be coded in columns 11-29, "person in charge" is defined as the person directing vessel handling operations. If the primary vessel is a tug/towboat barge array, the tug/towboat captain is the person in charge.

In coding columns 11-15, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IV.11 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for less than 1 hour.

NO = 0

YES = 1

NO DATA = 9

IV.12 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 1 to 4 hours.

NO = 0

YES = 1

NO DATA = 9

IV.13 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 5 to 8 hours.

NO = 0

YES = 1

NO DATA = 9

IV.14 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 9 to 12 hours.

NO = 0

YES = 1

NO DATA = 9

IV.15 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for more than 12 hours.

NO = 0

YES = 1

NO DATA = 9

In coding columns 16-20, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer NA if a special consulting pilot was in charge.

IV.16 At the time of the casualty, the person in charge had been continuously onboard between 1 and 10 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.17 The person in charge had been continuously onboard for 11 to 30 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.18 The person in charge had been continuously onboard for 31 to 60 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.19 The person in charge had been continuously onboard for 61 to 90 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.20 The person in charge had been continuously onboard for more than 90 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.21 If the master or mate was in charge did he have in-port duties prior to departure or did he have other non-watchstanding duties prior to in-bound transit? Note, a tug/towboat master may be called "captain."

NO = 0

YES = 1

NA = 8

NO DATA = 9

The second in command on a tug/towboat (equivalent to the first mate on a ship) may be called "pilot" or "relief master". The question applies to those regular tug/towboat personnel.

In coding columns 22-25, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Questions 22-25 apply to tug/towboat captain/master and pilot/relief master as well as to ship personnel.

IV.22 If the master or mate on watch had prior duties with no break, was he working 2 hours or less before taking charge of vessel handling operations? (Include tug/towboat captain/pilot.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

- IV.23 If the master or mate on watch had prior duties with no break, was he working 3 to 4 hours before taking charge of vessel handling operations?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.24 If the master or mate on watch had prior duties with no break, was he working 5 to 8 hours before taking charge of vessel handling operations?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.25 If the master or mate on watch had prior duties with no break, was he working more than 8 hours before taking charge of vessel handling operations?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.26 Had the person in charge sailed as such 2 or more times previously with a vessel of this type (i.e., bulk carrier, container ship, oil tanker, etc.)? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.27 Had the person in charge sailed as such 2 or more times previously on this particular vessel or a sister vessel? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.28 Had the person in charge sailed as such 2 or more times previously with a vessel in this size range? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9

- IV.29 Had the person in charge sailed the route two or more times previously?
(Answer YES if the person-in-charge was a state-licensed pilot or a special docking pilot)
- NO = 0
YES = 1
NO DATA = 9

PART VII: NAVIGATIONAL AIDS AND TASK PERFORMANCE ON THE PRIMARY VESSEL

If the primary vessel is a tug/towboat-barge array, answer the following questions for the tug/towboat.

- IV.30 Were navigational charts and publications available on the vessel?

NO = 0
YES = 1
NO DATA = 9

- IV.31 Were the charts and publications up-to-date and correct?

NO = 0
YES = 1
NA = 8
NO DATA = 9

- IV.32 If they were not up-to-date and correct, were the errors/omissions known to the person directing vessel handling operations?

NO = 0
YES = 1
NA = 8
NO DATA = 9

- IV.33 Were the charts and publications used prior to the casualty?

NO = 0
YES = 1
NA = 8
NO DATA = 9

- IV.34 Was the vessel equipped with a depth-sounder?

NO = 0
YES = 1
NO DATA = 9

- IV.35 If the vessel was equipped with a depth-sounder, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.36 If the vessel was equipped with a depth-sounder, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.37 If the vessel was equipped with a depth-sounder, did the operator and the person directing vessel handling operations know how to use it?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.38 Was the vessel equipped with radar?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.39 If the vessel was equipped with radar, was at least one radar capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.40 If the vessel was equipped with radar, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.41 Was there a bearing error in the radar?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.42 If there was a bearing error in the radar, was it known to the person directing vessel handling operations and the radar operator?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.43 If the vessel was equipped with radar, did both the operator and the person directing vessel handling know how to use it?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.44 Was the vessel equipped with a collision avoidance system (CAS)?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.45 If the vessel was equipped with CAS, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.46 If the vessel was equipped with CAS, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.47 If the vessel was equipped with CAS, did both the operator and the person directing vessel handling operations know how to use it?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.48 If the vessel was equipped with CAS and standard radar, were both capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.49 If the vessel was equipped with CAS and standard radar, were both on at the time of the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.50 Was the vessel equipped with an electronic navigation device (e.g., RDF, LORAN, DECCA, OMEGA).
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.51 Was there a service in the area where the casualty occurred compatible with the electronic navigation device(s) available on the vessel? (Answer NA if the vessel had no such device(s).)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.52 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.53 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.54 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, did the operator and the person directing vessel handling know how to use them?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.55 Was the vessel equipped with a wind speed and direction indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.56 If the vessel was equipped with a wind speed and direction indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.57 If the vessel was equipped with a wind speed and direction indicator, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.58 Was the vessel equipped with a wave height transducer?
- NO = 0
 - YES = 1
 - NO DATA = 9

IV.59 If the vessel was equipped with a wave height transducer, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.60 If the vessel was equipped with a wave height transducer, was it on prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.61 Was the vessel equipped with a speed indicator?

NO = 0

YES = 1

NO DATA = 9

IV.62 If the vessel was equipped with a speed indicator, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.63 Was the vessel equipped with both magnetic and gyro compasses?

NO = 0

YES = 1

NO DATA = 9

IV.64 Was the magnetic compass deviation and variation and gyro compass error known to the person in charge of vessel handling and other cognizant personnel on the bridge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

- IV.65 Was the vessel equipped with a rudder angle indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.66 If the vessel was equipped with a rudder angle indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.67 If the vessel was equipped with a rudder angle indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.68 Were there rudder angle indicator repeaters on the bridge wings? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.69 If there were repeaters on the bridge wings, were they in proper operating condition? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.70 Was the vessel equipped with an RPM indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9

IV.71 If the vessel was equipped with an RPM indicator, was it operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.72 If the vessel was equipped with an RPM indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.73 Were there RPM indicator repeaters available on the bridge wings? (Answer NA if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.74 If there were RPM indicator repeaters on the bridge wings, were they operating properly? (Answer NA if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.75 Was the vessel equipped with a rate of turn indicator?

NO = 0

YES = 1

NO DATA = 9

IV.76 If the vessel was equipped with a rate of turn indicator, was it operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.77 If the vessel was equipped with a rate of turn indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.80 ENTER "4" IN COLUMN 80. THIS COMPLETES CARD IV.

The following questions will be answered on Card V.

V.1-10 Duplicate the responses given on Card I, Columns 1 through 10.

V.11 Was the vessel equipped with a steering system status indicator and failure alarm?

NO = 0

YES = 1

NO DATA = 9

V.12 If the vessel was equipped with steering system status indicator and failure alarm, were they operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.13 Was the steering system operating at designed capability prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

- V.14 Was the vessel equipped with propulsion system status indicator and failure alarm?
NO = 0
YES = 1
NO DATA = 9
- V.15 If the vessel was equipped with propulsion system status indicator and failure alarm, were they operating properly?
NO = 0
YES = 1
NO DATA = 9
- V.16 Was the propulsion system operating at designed capability prior to the casualty?
NO = 0
YES = 1
NO DATA = 9
- V.17 Was bridge-to-bridge radio equipment onboard?
NO = 0
YES = 1
NO DATA = 9
- V.18 Was radio equipment in proper operating condition?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.19 Was radio on prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.20 Was Channel 13 being monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9

- V.21 Was Channel 16 being monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.22 Were marine weather forecasts available? (Answer YES unless told otherwise.)
NO = 0
YES = 1
NO DATA = 9
- V.23 If marine weather forecasts were available, had they been monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.24 Was any other local information broadcast (e.g., VTS or other harbor advisory broadcasts).
NO = 0
YES = 1
NO DATA = 9
- V.25 If any other local information was broadcast, was this monitored prior to the casualty?
NO = 0
YES = 1
NO DATA = 9
- V.26 Was any effort made to detect hazards and aids to navigation (includes natural and other landmarks).
NO = 0
YES = 1
NO DATA = 9

In coding columns 27-29, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- V.27 Was visual watch only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NO DATA = 9
- V.28 Were both electronic equipment and visual watch being used to detect hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.29 Was electronic equipment only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.30 Was it possible to detect hazards and aids to navigation from the bridge or pilot house by visual watch? (Answer NO if there was some aspect of vessel design or cargo loading that limited visual observation. Do not consider the atmospheric condition in answering this question.)
- NO = 0
YES = 1
NO DATA = 9
- V.31 Was there a lookout (a bow lookout on a ship or a lookout otherwise stationed on a tug/towboat-barge array)?
- NO = 0
YES = 1
NO DATA = 9

- V.32 Did the lookout make any report?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.33 If the lookout made a report, was it made in time so that avoidance action could be taken?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.34 If the lookout made a report, was it understood?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.35 Were all hazards and aids mentioned as significant in the casualty report detected by the person-in-charge?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.36 Were all hazards and aids mentioned as significant in the casualty report correctly identified by the person-in-charge?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.37 Was any effort made to establish navigational position prior to the casualty?
- NO = 0
 - YES = 1
 - NO DATA = 9

Only one YES may be coded in columns 38-40.

V.38 Was navigational position being established by visual estimation only prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.39 Was electronic equipment only being used to establish navigational position prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.40 Was navigational position being established by a combination of visual and electronic means prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.41 Was navigational position correctly established?

NO = 0

YES = 1

NO DATA = 9

V.42 Was navigational position being plotted on chart prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

V.43 Was any attempt made to ascertain wind speed and direction prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 44-46, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.44 Were wind speed and direction ascertained by sensory perception only (visual and other means)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.45 Were wind speed and direction ascertained from an indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.46 Were wind speed and direction ascertained by a combination of sensory perception and indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.47 Were wind speed and direction correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

V.48 Was any attempt made to ascertain current direction and speed prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 49-55, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.49 Were current direction and speed ascertained from publications and/or experience?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.50 Were current speed and direction ascertained by visual (and other sensory) perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.51 Were current direction and speed ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.52 Were current speed and direction ascertained by a combination of publications/experience and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.53 Were current speed and direction ascertained by a combination of publications/experience and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.54 Were current speed and direction ascertained by a combination of sensory perception and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.55 Were current direction and speed ascertained by a combination of publications/experience, sensory perception, and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.56 Were current direction and speed ascertained correctly.

NO = 0

YES = 1

NO DATA = 9

V.57 Was any attempt made to ascertain the tidal condition?

NO = 0

YES = 1

NO DATA = 9

In coding columns 58-60, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.58 Was the tidal condition ascertained from publications and/or local knowledge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.59 Was the tidal condition ascertained by visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.60 Was the tidal condition ascertained from a combination of publications/
local knowledge and visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.61 Was the tidal condition correctly ascertained?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.62 Was any attempt made to ascertain wave height?

NO = 0

YES = 1

NO DATA = 9

In coding columns 63-65, NO DATA is valid only if all of the questions are
answered NO DATA. Only one may be answered YES.

V.63 Was wave height ascertained by visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.64 Was wave height ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.65 Was wave height ascertained from a combination of visual estimation
and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.66 Wave wave height properly ascertained?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.67 Was any attempt made to ascertain speed?

NO = 0

YES = 1

NO DATA = 9

In coding columns 68-70, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES.

V.68 Was speed ascertained by a speed indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.69 Was speed ascertained by sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.70 Was speed ascertained by a combination of indicator and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.71 Was speed correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

V.72 Was compass heading ascertained?

NO = 0

YES = 1

NO DATA = 9

V.73 Was rudder angle ascertained?

NO = 0

YES = 1

NO DATA = 9

V.74 Was RPM ascertained?

NO = 0

YES = 1

NO DATA = 9

V.75 Were rudder commands conveyed directly to the helmsman? (Answer NA if the vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 76-78, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.76 Were propeller orders conveyed to the engine room verbally? (Answer NA if the primary vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.77 Were propeller orders conveyed to the engine room mechanically? (Answer NA if the primary vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.78 Were propeller orders effected directly through bridge control?
(Answer NA if the vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.80 ENTER "5" IN COLUMN 80. THIS COMPLETES CARD V.

The following questions will be answered on Card 6.

PART VIII: DESCRIPTION OF THE "OTHER" VESSEL IN AN UNDERWAY COLLISION

VI.1-10 Duplicate the responses given on Card I, Columns 1 through 10.

More than one YES may be used in answering questions 19-21 to cover mixed barge arrays. For example, if the array includes one or more tank barges and one or more general cargo barges, then both questions 11 and 12 would both be answered YES. If that array also included some other kind of barge, then question 13 would also be answered YES.

In coding columns 11-24, NO DATA is valid only if all of the questions are answered NO DATA.

VI.11 Was the other vessel a tug/towboat-barge configuration with one or more tank barges?

NO = 0

YES = 1

NO DATA = 9

VI.12 Was the other vessel a tug/towboat-barge configuration with one or more general purpose cargo barges?

NO = 0

YES = 1

NO DATA = 9

VI.13 Was the other vessel a tug/towboat-barge configuration with one or more barges not otherwise classified?

NO = 0

YES = 1

NO DATA = 9

- VI.14 Was the other vessel a tank ship of more than 10,000 GRT?
NO = 0
YES = 1
NO DATA = 9
- VI.15 Was the other vessel a tank ship of 10,000 GRT or less?
NO = 0
YES = 1
NO DATA = 9
- VI.16 Was the other vessel a cargo ship of more than 10,000 GRT?
NO = 0
YES = 1
NO DATA = 9
- VI.17 Was the other vessel a cargo ship of 10,000 GRT or less?
NO = 0
YES = 1
NO DATA = 9
- VI.18 Was the other vessel a passenger ship of more than 10,000 GRT?
NO = 0
YES = 1
NO DATA = 9
- VI.19 Was the other vessel a passenger ship of 10,000 GRT or less?
NO = 0
YES = 1
NO DATA = 9
- VI.20 Was the other vessel a service vessel such as a crew or supply boat, pilot boat, tender, or a tug/towboat that was not part of the primary vessel configuration?
NO = 0
YES = 1
NO DATA = 9

- VI.21 Was the other vessel a construction, wrecking, or other special-purpose vessel (include pipelaying barge, dredge, pile-driver, drilling unit, etc.)?
- NO = 0
YES = 1
NO DATA = 9
- VI.22 Was the other vessel a commercial fishing vessel?
- NO = 0
YES = 1
NO DATA = 9
- VI.23 Was the other vessel a recreational boat?
- NO = 0
YES = 1
NO DATA = 9
- VI.24 Was the other vessel another kind of vessel not covered in Questions 11-23?
- NO = 0
YES = 1
NO DATA = 9
- VI.25 Does the report indicate that this casualty resulted from a sudden failure of propulsion or steering, from a cataclysmic event, or from action on the part of the primary vessel such that the other vessel did not contribute to the casualty occurrence and could not have avoided it?
- NO = 0
YES = 1

If the answer to Question 25 is YES, enter "6" in Column 80 of Card VI and go to Card XII.

If the answer to question 25 is NO, and the other vessel is in one of the categories defined in questions 20-24, leave the rest of Card VI blank and go to Card X.

If the answer to Question 25 is NO and the other vessel is one of categories defined in Questions 11-19, proceed with coding this card.

VI.26 If the other vessel was a ship, was it being assisted by one or more tugboats or towboats?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In answering Questions 27-29, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for tug/towboat-barge configurations, considering all tugs/towboats as assisting vessels.

VI.27 If the other vessel was assisted, was there just one assisting vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.28 If the other vessel was assisted, were there two assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.29 If the other vessel was assisted, were there three or more assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.30 Were tugs (one or more) standing by?

NO = 0

YES = 1

Code NA in columns 31-47, if the other vessel was not a tug/towboat-barge configuration. In coding columns 31-35, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VI.31 If the other vessel was a tug/towboat-barge configuration, was there just one barge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.32 Were there two or three barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.33 Were there four or five barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.34 Were there 6 to 10 barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.35 Were there more than 10 barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 36-38, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VI.36 If the other vessel was a tug/towboat-barge configuration, was there just one barge across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.37 Were there two barges across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.38 Were there three or more barges across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 39-41, NO DATA is valid only if all of the questions are answered NO DATA.

VI.39 If the other vessel was a tug/towboat-barge configuration, was the barge/barge array being pulled at the end of the hawser?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.40 Was the barge or barge array being pushed from astern?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.41 Were tug(s)/towboat(s) alongside?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.42 Was it an integrated tug/towboat-barge configuration?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.43 Was the barge or barge array in a loaded condition?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.44 Was the barge or barge array empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.45 Were some barges loaded and some empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.46 If the other vessel was a tug/towboat-barge configuration was its movement a one-man operation (i.e., a single assisting vessel with a single operator)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.47 Was it a Western Rivers type towboat-barge configuration? (Note: Tug/towboat pushes from astern. Not integrated. Array size up to 6 x 7.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

Only one of columns 48 and 49 may be coded YES.

VI.48 If the other vessel was a ship, was it carrying cargo?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.49 If the other vessel was a ship, was it in ballast? (Note: Assume the ship was in ballast if it was not carrying cargo, unless told otherwise.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.50 If the other vessel was moving with assistance, was it using on-board propulsive units as well? (Answer NA if the other vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.51 If the other vessel was moving with assistance, did one or more of the assisting vessel (or vessels) have lateral thrusters or CP propellers? (Answer for the tug(s) or towboat(s) moving barges.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.52 If the other vessel was moving without assistance, did it have lateral thrusters or CP propellers? (Answer NA if the other vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 53-55, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VI.53 If the other vessel was a ship, was the bridge located forward?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.54 If the other vessel was a ship, was the bridge located midships?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VI.55 If the other vessel was a ship, was the bridge located aft?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 56-58, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VI.56 The vessel tonnage was 10,000 GRT or less. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

VI.57 The vessel tonnage was more than 10,000 GRT to 15,000 GRT. (For barge arrays, take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

VI.58 The vessel tonnage was more than 15,000 GRT. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 59-63, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VI.59 The vessel length was less than 100 feet. (For barge arrays take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

VI.60 The vessel length was 100 feet to less than 300 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

VI.61 The vessel length was 300 feet to less than 500 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

- VI.62 The vessel length was 500 feet to less than 700 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)
- NO = 0
YES = 1
NO DATA = 9
- VI.63 The vessel length was 700 feet or more. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)
- NO = 0
YES = 1
NO DATA = 9

In coding columns 64-66, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- VI.64 If the barge/barge array was being pulled at the end of a hawser, the hawser length was less than 300 feet.
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VI.65 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 300 feet to less than 600 feet.
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VI.66 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 600 feet or more.
- NO = 0
YES = 1
NA = 8
NO DATA = 9

In coding columns 67-70, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- VI.67 The vessel's under keel clearance prior to the casualty was less than 1 foot.
- NO = 0
YES = 1
NO DATA = 9
- VI.68 The vessel's under keel clearance prior to the casualty was 1 foot to less than 2 feet.
- NO = 0
YES = 1
NO DATA = 9
- VI.69 The vessel's under keel clearance prior to the casualty was 2 feet to less than 4 feet.
- NO = 0
YES = 1
NO DATA = 9
- VI.70 The vessel's under keel clearance prior to the casualty was 4 feet or more.
- NO = 0
YES = 1
NO DATA = 9
- VI.71 Did the vessel have just one propeller? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.) Note: On a tug/ towboat, the number of engines corresponds to the number of propellers. On a ship there is not necessarily any correspondence.)
- NO = 0
YES = 1
NO DATA = 9
- VI.72 Did the vessel have two propellers? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)
- NO = 0
YES = 1
NO DATA = 9

- VI.73 Did the vessel have just one rudder? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)
 NO = 0
 YES = 1
 NO DATA = 9
- VI.74 Did the vessel have two rudders? (If the vessel was a barge/barge array under tow, answer for the tug/towboat.)
 NO = 0
 YES = 1
 NO DATA = 9
- VI.75 If the vessel was a barge/barge array under tow, did the tug/towboat have a flanking rudder? (Note: A tug/towboat may have a flanking rudder only; i.e., having a flanking rudder does not necessarily mean the vessel has two rudders.)
 NO = 0
 YES = 1
 NA = 8
 NO DATA = 9
- VI.76 Was the rudder capable of going 35 deg. on either side of midships? (If the primary vessel was a barge/barge array under tow, answer for the tug/towboat.)
 NO = 0
 YES = 1
 NO DATA = 9
- VI.77. Was the rudder capable of going more than 35 deg. on either side of midships? (If the primary vessel was a barge/barge array under tow, answer for the tug/towboat.)
 NO = 0
 YES = 1
 NO DATA = 9

VI.80 ENTER "6" IN COLUMN 80. THIS COMPLETES CARD VI.

The answers to the following questions will be coded for Card VII.

VII.1-10 Duplicate the codes for Card I, columns 1 through 10.

VII.11 If the other vessel was a ship, was there bridge control of the main propulsion system?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.12 If the other vessel was a ship, was the main propulsion system steam?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.13 If the vessel was a ship, was the main propulsion system diesel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.14 If the vessel was a ship, was the main propulsion system gas turbine?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.15 Was the other vessel a registered vessel of the United States?

NO = 0

YES = 1

NO DATA = 9

VII.16 Was the other vessel foreign registered?

NO = 0

YES = 1

NO DATA = 9

VII.17 Was the other vessel inspected by the U.S. Coast Guard?

NO = 0

YES = 1

NO DATA = 9

VII.18. Was the other vessel displaying proper lights or other signals as required under the operating conditions? (Answer YES unless the report states otherwise.)

NO = 0

YES = 1

VII.19 Did the other vessel sound proper signals as required under operating condition? (Answer YES unless the report states otherwise.)

NO = 0

YES = 1

VII.20 If the other vessel did not display and/or sound proper signals, were the means available/operative?

NO = 0

YES = 1

NA = 8

NO DATA = 9

PART IX: ENVIRONMENTAL CONDITIONS IN RELATION TO THE OTHER VESSEL

In coding columns 21-25, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for the other vessel.

VII.21 The wind direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.22 The wind direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.23 The wind direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

VII.24 The wind direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

VII.25 The wind direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

In coding columns 26-30, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer for the other vessel.

VII.26 The wave direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.27 The wave direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.28 The wave direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

VII.29 The wave direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

VII.30 The wave direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

In coding columns 31-35, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES. Answer for the other vessel.

VII.31 The current direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.32 The current direction relative to ship's center line was parallel against the ship's direction.

NO = 0

YES = 1

NO DATA = 9

VII.33 The current direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

VII.34 The current direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

VII.35 The current direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

VII.36 Did the vessel encounter a sudden change in wind, current, and/or tide action shortly before the casualty? Answer for the other vessel.

NO = 0

YES = 1

NO DATA = 9

PART X: SCENARIO OF OTHER VESSEL OPERATIONS PRIOR TO THE CASUALTY

In coding columns 37-47, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES. Answer for other vessel.

VII.37 Was the vessel in the process of anchoring or disengaging anchor?

NO = 0

YES = 1

NO DATA = 9

VII.38 Was the vessel in the process of mooring/unmooring or docking/undocking?

NO = 0

YES = 1

NO DATA = 9

VII.39 Was the vessel just passing by (not entering or exiting a port)?

NO = 0

YES = 1

NO DATA = 9

VII.40 Was the vessel inbound?

NO = 0

YES = 1

NO DATA = 9

VII.41 Was the vessel outbound?

NO = 0

YES = 1

NO DATA = 9

VII.42 Was the vessel passing through port?

NO = 0

YES = 1

NO DATA = 9

VII.43 Was the vessel making an intra-port move?

NO = 0

YES = 1

NO DATA = 9

- VII.44 Was the vessel negotiating or close approaching a bridge or lock when the casualty occurred?
- NO = 0
YES = 1
NO DATA = 9
- VII.45 If the vessel was negotiating or close approaching a bridge, was it a drawbridge?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VII.46 Was the vessel negotiating or close approaching a sharp turn (more than 20 degrees) when the casualty occurred?
- NO = 0
YES = 1
NO DATA = 9
- VII.47 If the vessel was a tug/towboat-barge configuration, had it been intentionally set aground just prior to the casualty?
- NO = 0
YES = 1
NO DATA = 9
- VII.48 Had there been a delay of 2 hours or more in the scheduled movement of the vessel?
- NO = 0
YES = 1
NO DATA = 9

- VII.49 Did the person directing vessel handling operations have a federal pilot's license?
- NO = 0
YES = 1
NO DATA = 9
- VII.50 Did the person directing vessel handling operations have a state pilot's license?
- NO = 0
YES = 1
NO DATA = 9
- VII.51 Did the person directing vessel handling operations have some other kind of license pertinent to vessel handling?
- NO = 0
YES = 1
NO DATA = 9
- VII.52 Was the person directing vessel handling operations a special, consulting pilot (not among the regular vessel personnel; someone who comes aboard to guide the vessel in the port area)?
- NO = 0
YES = 1
NO DATA = 9
- VII.53 Was the person directing vessel handling a docking pilot (a specialist in directing docking/mooring maneuvers)?
- NO = 0
YES = 1
NO DATA = 9
- VII.54 Did the special consulting pilot and any assisting vessel(s) come from a common organization? (Anser NA if there were no assisting vessels and/or no special, consulting pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

VII.55 Was the master directing vessel handling operations?

NO = 0

YES = 1

NO DATA = 9

VII.56 Was the mate on watch directing vessel handling operations? (Include "pilot" of a tug/towboat; this pilot is among the regular tug/towboat personnel and is second in command to the master/captain).

NO = 0

YES = 1

NO DATA = 9

VII.57 Was someone else directing vessel handling operations?

NO = 0

YES = 1

NO DATA = 9

VII.58 If a special, consulting pilot was directing the vessel handling operations, was the master present?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.59 If a special, consulting pilot was directing vessel handling operations, did the master take over?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.60 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a land pilot station or the home office?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.61 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a pilot boat?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.62 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.63 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8 to 16-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.64 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 17 to 24-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

For the following questions, "person in charge" is defined as the person directing vessel handling operations. If the vessel is a tug/towboat barge array, the tug/towboat captain is the person in charge.

In coding columns 65-69, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

VII.65 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for less than 1 hour.

NO = 0

YES = 1

NO DATA = 9

VII.66 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 1 to 4 hours.

NO = 0

YES = 1

NO DATA = 9

VII.67 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 5 to 8 hours.

NO = 0

YES = 1

NO DATA = 9

VII.68 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 9 to 12 hours.

NO = 0

YES = 1

NO DATA = 9

VII.69 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for more than 12 hours.

NO = 0

YES = 1

NO DATA = 9

In coding columns 70-74, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Code NA if a special consulting pilot was in charge.

VII.70 At the time of the casualty, the person in charge had been continuously onboard between 1 and 10 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.71 The person in charge had been continuously onboard for 11 to 30 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.72 The person in charge had been continuously onboard for 31 to 60 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.73 The person in charge had been continuously onboard for 61 to 90 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.74 The person in charge had been continuously onboard for more than 90 days.

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.75 If the master or mate was in charge did he have in-port duties prior to departure or did he have other non-watchstanding duties prior to in-bound transit? (Note, a tug/towboat master may be called "captain." The second in command on a tug/towboat (equivalent to the first mate on a ship) may be called "pilot" or "relief master." The question applies to those regular tug/towboat personnel.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VII.80 THIS COMPLETES CARD 7. ENTER "7" IN COLUMN 80.

VIII.1-10 Duplicate the responses given on Card 1, columns 1 through 10.

In coding columns 11-14, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Questions 11-14 apply to tug/towboat captain/master and pilot/relief master, as well as to ship personnel.

VIII.11 If the master or mate on watch had prior duties with no break, was he working 2 hours or less before taking charge of vessel handling operations?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.12 If the master or mate on watch had prior duties with no break, was he working 3 to 4 hours before taking charge of vessel handling operations?

NO = 0

YES = 1

NA = 8

NO DATA = 9

- VIII.13 If the master or mate on watch had prior duties with no break, was he working 5 to 8 hours before taking charge of vessel handling operations?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.14 If the master or mate on watch had prior duties with no break, was he working more than 8 hours before taking charge of vessel handling operations?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.15 Had the person in charge sailed as such 2 or more times previously with a vessel of this type (i.e., bulk carrier, container ship, oil tanker, etc.)? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9
- VIII.16 Had the person in charge sailed as such 2 or more times previously on this particular vessel or a sister vessel? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9
- VIII.17 Had the person in charge sailed as such 2 or more times previously with a vessel in this size range? (Include tug/towboat-barge array.)
- NO = 0
 - YES = 1
 - NO DATA = 9

VIII.18 Had the person in charge sailed the route two or more times previously?
(Answer YES if the person in charge was a state pilot or special docking pilot.)

NO = 0

YES = 1

NO DATA = 9

PART XI: NAVIGATIONAL AIDS AND TASK PERFORMANCE ON THE OTHER VESSEL

If the other vessel is a tug/towboat-barge array, answer the following questions for the tug/towboat.

VIII.19 Were navigational charts and publications available on the vessel?

NO = 0

YES = 1

NO DATA = 9

VIII.20 Were the charts and publications up-to-date and correct?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.21 If they were not up-to-date and correct, were the errors/omissions known to the person directing vessel handling operations?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.22 Were the charts and publications used prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.23 Was the vessel equipped with a depth-sounder?

NO = 0

YES = 1

NO DATA = 9

VIII.24 If the vessel was equipped with a depth-sounder, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.25 If the vessel was equipped with a depth-sounder, was it on prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.26 If the vessel was equipped with a depth-sounder, did the operator and the person directing vessel handling operations know how to use it?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.27 Was the vessel equipped with radar?

NO = 0

YES = 1

NO DATA = 9

VIII.28 If the vessel was equipped with radar, was at least one radar capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.29 If the vessel was equipped with radar, was it on prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.30 Was there a bearing error in the radar?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.31 If there was a bearing error in the radar, was it known to the person directing vessel handling operations and the radar operator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.32 If the vessel was equipped with radar, did both the operator and the person directing vessel handling know how to use it?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.33 Was the vessel equipped with a collision avoidance system (CAS)?

NO = 0

YES = 1

NO DATA = 9

VIII.34 If the vessel was equipped with CAS, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.35 If the vessel was equipped with CAS, was it on prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

- VIII.36 If the vessel was equipped with CAS, did both the operator and the person directing vessel handling operations know how to use it?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.37 If the vessel was equipped with CAS and standard radar, were both capable of operating properly?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.38 If the vessel was equipped with CAS and standard radar, were both on at the time of the casualty?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.39 Was the vessel equipped with an electronic navigation device (e.g., RDF, LORAN, DECCA, OMEGA).
- NO = 0
YES = 1
NO DATA = 9
- VIII.40 Was there a service in the area where the casualty occurred compatible with the electronic navigation device(s) available on the vessel? (Answer NA if the vessel had no such device(s).)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.41 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one capable of operating properly?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

- VIII.42 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.43 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, did the operator and the person directing vessel handling know how to use them?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.44 Was the vessel equipped with a wind speed and direction indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- VIII.45 If the vessel was equipped with a wind speed and direction indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.46 If the vessel was equipped with a wind speed and direction indicator, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.47 Was the vessel equipped with a wave height transducer?
- NO = 0
 - YES = 1
 - NO DATA = 9

VIII.48 If the vessel was equipped with a wave height transducer, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.49 If the vessel was equipped with a wave height transducer, was it on prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.50 Was the vessel equipped with a speed indicator?

NO = 0

YES = 1

NO DATA = 9

VIII.51 If the vessel was equipped with a speed indicator, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.52 Was the vessel equipped with both magnetic and gyro compasses?

NO = 0

YES = 1

NO DATA = 9

VIII.53 Was the magnetic compass deviation and variation and gyro compass error known to the person in charge of vessel handling and other cognizant personnel on the bridge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.54 Was the vessel equipped with a rudder angle indicator?

NO = 0

YES = 1

NO DATA = 9

VIII.55 If the vessel was equipped with a rudder angle indicator, was it capable of operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.56 If the vessel was equipped with a rudder angle indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/bar array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.57 Were there rudder angle indicator repeaters on the bridge wings? (Answer NA if the vessel was a barge/bar array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.58 If there were repeaters on the bridge wings, were they in proper operating condition? (Answer NA if the vessel was a barge/bar array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.59 Was the vessel equipped with an RPM indicator?

NO = 0

YES = 1

NO DATA = 9

- VIII.60 If the vessel was equipped with an RPM indicator, was it operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.61 If the vessel was equipped with an RPM indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.62 Were there RPM indicator repeaters available on the bridge wings? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.63 If there were RPM indicator repeaters on the bridge wings, were they operating properly? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- VIII.64 Was the vessel equipped with a rate of turn indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9

VIII.65 If the vessel was equipped with a rate of turn indicator, was it operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.66 If the vessel was equipped with a rate of turn indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.67 Was the vessel equipped with a steering system status indicator and failure alarm?

NO = 0

YES = 1

NO DATA = 9

VIII.68 If the vessel was equipped with steering system status indicator and failure alarm, were they operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.69 Was the steering system operating at designed capability prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

- VIII.70 Was the vessel equipped with propulsion system status indicator and failure alarm?
- NO = 0
YES = 1
NO DATA = 9
- VIII.71 If the vessel was equipped with propulsion system status indicator and failure alarm, were they operating properly?
- NO = 0
YES = 1
NO DATA = 9
- VIII.72 Was the propulsion system operating at designed capability prior to the casualty?
- NO = 0
YES = 1
NO DATA = 9
- VIII.73 Was bridge-to-bridge radio equipment onboard?
- NO = 0
YES = 1
NO DATA = 9
- VIII.74 Was radio equipment in proper operating condition?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.75 Was radio on prior to the casualty?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- VIII.76 Was Channel 13 being monitored prior to the casualty?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

VIII.77 Was Channel 16 being monitored prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

VIII.80 ENTER "8" IN COLUMN 80. THIS COMPLETES CARD VIII.

IX.1-10 Duplicate the responses given on Card I, columns 1-10.

IX.11 Were marine weather forecasts available? Answer YES unless otherwise specified.

NO = 0

YES = 1

NO DATA = 9

IX.12 If marine weather forecasts were available, had they been monitored prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.13 Was any other local information broadcast (e.g., VTS or other harbor advisory broadcasts).

NO = 0

YES = 1

NO DATA = 9

IX.14 If any other local information was broadcast, was this monitored prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

IX.15 Was any effort made to detect hazards and aids to navigation (includes natural and other landmarks).

NO = 0

YES = 1

NO DATA = 9

In coding columns 16-18, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- IX.16 Was visual watch only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NO DATA = 9
- IX.17 Were both electronic equipment and visual watch being used to detect hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.18 Was electronic equipment only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.19 Was it possible to detect hazards and aids to navigation from the bridge or pilot house by visual watch? (Answer NO if there was some aspect of vessel design or cargo loading that limited visual observation. Do not consider the atmospheric condition in answering this question.)
- NO = 0
YES = 1
NO DATA = 9
- IX.20 Was there a lookout (a bow lookout on a ship or a lookout otherwise stationed on a tug/towboat-barge array)?
- NO = 0
YES = 1
NO DATA = 9

- IX.21 Did the lookout make any report?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.22 If the lookout made a report, was it made in time so that avoidance action could be taken?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.23 If the lookout made a report, was it understood?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.24 Were all hazards and aids mentioned as significant in the casualty report detected by the person in charge?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.25 Were all hazards and aids mentioned as significant in the casualty report correctly identified by the person in charge?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- IX.26 Was any effort made to establish navigational position prior to the casualty?
NO = 0
YES = 1
NO DATA = 9

In coding columns 27-29, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IX.27 Was navigational position being established by visual estimation only prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.28 Was navigational position being established by electronic equipment only prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.29 Was navigational position being established by a combination of visual and electronic means prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.30 Was navigational position correctly established?

NO = 0

YES = 1

NO DATA = 9

IX.31 Was navigational position being plotted on chart prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

IX.32 Was any attempt made to ascertain wind speed and direction prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 33-35, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IX.33 Were wind speed and direction ascertained by sensory perception only (visual and other means)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.34 Were wind speed and direction ascertained from an indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.35 Were wind speed and direction ascertained by a combination of sensory perception and indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.36 Were wind speed and direction correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

IX.37 Was any attempt made to ascertain current direction and speed prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 38-44, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IX.38 Were current direction and speed ascertained from publications and/or experience?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.39 Were current speed and direction ascertained by visual (and other sensory) perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.40 Were current direction and speed ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.41 Were current speed and direction ascertained by a combination of publications/experience and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.42 Were current speed and direction ascertained by a combination of publications/experience and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.43 Were current speed and direction ascertained by a combination of sensory perception and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.44 Were current direction and speed ascertained by a combination of publications/experience, sensory perception, and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.45 Were current direction and speed ascertained correctly.

NO = 0

YES = 1

NO DATA = 9

IX.46 Was any attempt made to ascertain the tidal condition?

NO = 0

YES = 1

NO DATA = 9

In coding columns 47-49, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IX.47 Was the tidal condition ascertained from publications and/or local knowledge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.48 Was the tidal condition ascertained by visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.49 Was the tidal condition ascertained from a combination of publications/
local knowledge and visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.50 Was the tidal condition correctly ascertained?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.51 Was any attempt made to ascertain wave height?

NO = 0

YES = 1

NO DATA = 9

In coding columns 52-54, NO DATA is valid only if all of the questions are
answered NO DATA. Only one may be answered YES.

IX.52 Was wave height ascertained by visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.53 Was wave height ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.54 Was wave height ascertained from a combination of visual estimation
and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.55 Wave wave height properly ascertained?.

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.56 Was any attempt made to ascertain speed?

NO = 0

YES = 1

NO DATA = 9

In coding columns 57-59, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES.

IX.57 Was speed ascertained by a speed indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.58 Was speed ascertained by sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.59 Was speed ascertained by a combination of indicator and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.60 Was speed correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

IX.61 Was compass heading ascertained?

NO = 0

YES = 1

NO DATA = 9

IX.62 Was rudder angle ascertained?

NO = 0

YES = 1

NO DATA = 9

IX.63 Was RPM ascertained?

NO = 0

YES = 1

NO DATA = 9

IX.64 Were rudder commands conveyed directly to the helmsman? (Answer NA if the vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 65-67, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IX.65 Were propeller orders conveyed to the engine room verbally?
(Answer NA if the primary vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.66 Were propeller orders conveyed to the engine room mechanically?
(Answer NA if the primary vessel was a tug/towboat-barge configuration.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

AD-A071 058

ORI INC SILVER SPRING MD

F/G 13/10

STUDY OF TASK PERFORMANCE PROBLEMS IN REPORTS OF COLLISIONS, RAM--ETC(U)

MAR 79 B PARAMORE, V KEITH, P KING

DOT-CG-41903-A

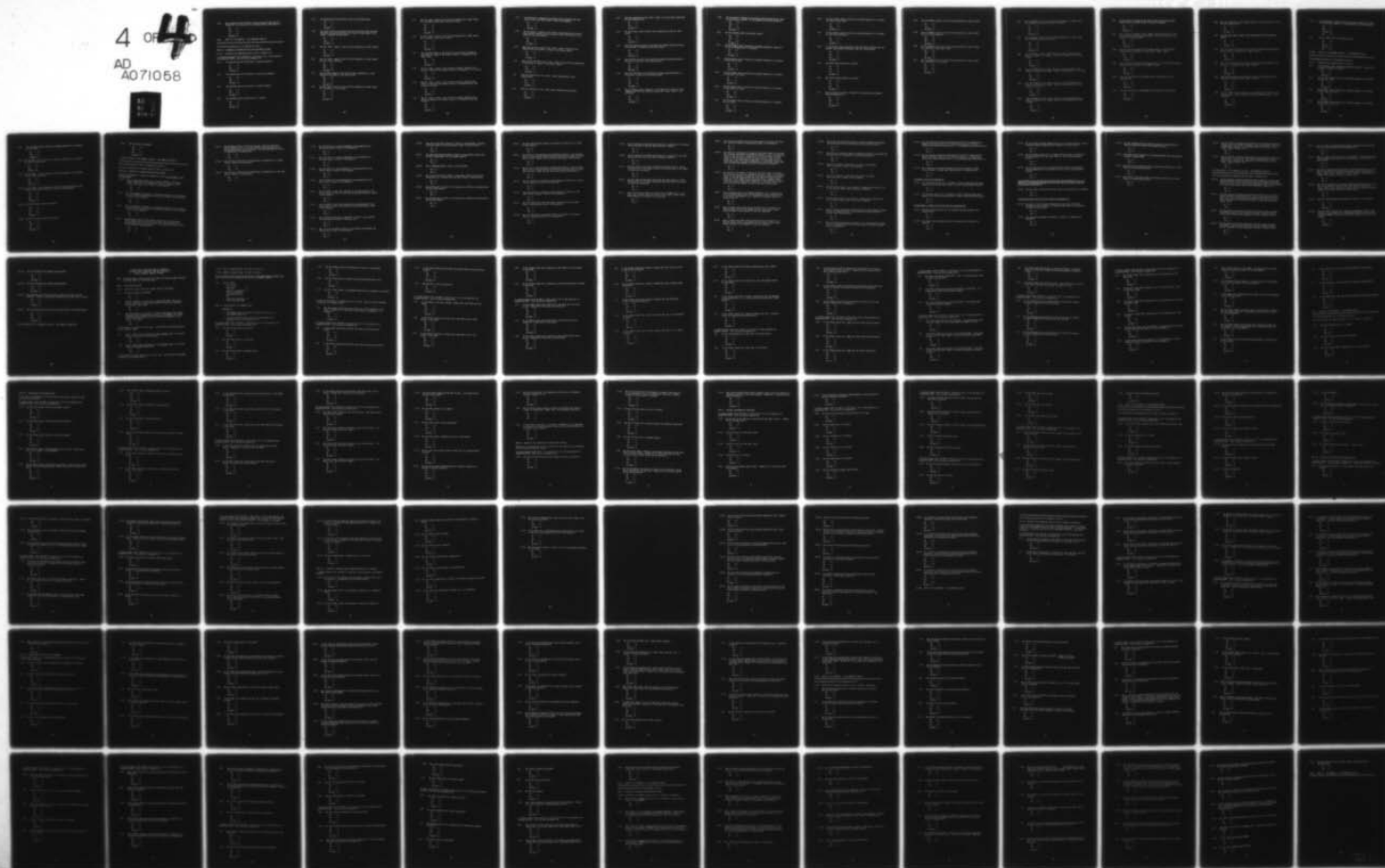
UNCLASSIFIED

ORI-TR-1474

USCG -D-28-79

NL

4 OF 4
AD
A071058





MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

IX.67 Were propeller orders effected directly through bridge
(Answer NA if the vessel was a tug/towboat-barge confi

NO = 0

YES = 1

NA = 8

NO DATA = 9

IX.80 ENTER "9" IN COLUMN 80. THIS COMPLETES CARD IX.

The following questions will be answered on Card X.

PART XII: ENCOUNTER SITUATION AND COLLISION AVOIDANCE ACTIONS

X.1-10 Duplicate the responses given on Card I, Columns 1-10.

In answering questions 11-15, NO DATA is valid only if all of th
are answered NO DATA. Only one may be answered YES.

X.11 The encounter may be classified as a parallel meeting.

NO = 0

YES = 1

NO DATA = 9

X.12 The encounter may be classified as a parallel overtaki

NO = 0

YES = 1

NO DATA = 9

X.13 The encounter may be classified as a head-on meeting.

NO = 0

YES = 1

NO DATA = 9

X.14 The encounter may be classified as a crossing.

NO = 0

YES = 1

NO DATA = 9

- X.15 The encounter was of some other kind not classified above.
- NO = 0
YES = 1
NO DATA = 9
- X.16 Was there a bend or some other physical obstruction that prevented detection (by unaided sighting or by radar) at some stage of the vessels' approach to each other?
- NO = 0
YES = 1
NO DATA = 9
- X.17 Was the other vessel in the collision detected as a radar target?
- NO = 0
YES = 1
NO DATA = 9
- X.18 Was the other vessel in the collision detected as a radar target prior to visual sighting?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- X.19 Was the other vessel in the collision first detected as a radar target at a distance of less than 1 mile?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- X.20 Was the other vessel in the collision detected as a radar target at a distance of 1 to 2 miles?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

X.21 Was the other vessel in the collision detected as a radar target at a distance of more than 2 miles to 5 miles?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.22 Was the other vessel in the collision detected as a radar target at a distance of more than 5 miles?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.23 Was the other vessel in the collision first visually sighted by the person in charge of the primary vessel at a distance of less than 1 mile?

NO = 0

YES = 1

NO DATA = 9

X.24 Was the other vessel in the collision visually sighted by the person in charge of the primary vessel at a distance of 1 to 2 miles?

NO = 0

YES = 1

NO DATA = 9

X.25 Was the other vessel in the collision visually sighted by the person in charge of the primary vessel at a distance of more than 2 miles to 5 miles?

NO = 0

YES = 1

NO DATA = 9

X.26 Was the other vessel in the collision visually sighted by the person in charge of the primary vessel at a distance of more than 5 miles?

NO = 0

YES = 1

NO DATA = 9

- X.27 Did the person in charge of the primary vessel perceive the other vessel to be a collision threat in time for avoidance?
- NO = 0
YES = 1
NO DATA = 9
- X.28 Did the person in charge of the primary vessel perceive one or more other vessels (besides the one involved in this collision) to be a potential collision threat?
- NO = 0
YES = 1
NO DATA = 9
- X.29 Were the course and speed of the other vessel in the collision determined by the person in charge of the primary vessel?
- NO = 0
YES = 1
NO DATA = 9
- X.30 Were the CPA and TCPA of the other vessel in the collision determined by the person in charge of the primary vessel?
- NO = 0
YES = 1
NO DATA = 9
- X.31 Were the intentions of the other vessel determined by visual observations?
- NO = 0
YES = 1
NO DATA = 9
- X.32 Were the intentions of the other vessel determined by plotting?
- NO = 0
YES = 1
NO DATA = 9

X.33 Were the intentions of the other vessel in the collision determined by radio communication?

NO = 0

YES = 1

NO DATA = 9

X.34 Did the primary vessel attempt radio communication with the other vessel?

NO = 0

YES = 1

NO DATA = 9

X.35 Were the course and speed of any additional vessels being determined by the person in charge of the primary vessel?

NO = 0

YES = 1

NO DATA = 9

X.36 Were the CPA and TCPA of any additional vessels being determined by the person in charge of the primary vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.37 Were the intentions of any additional vessels being determined by the person in charge of the primary vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.38 Was the primary vessel engaging in or attempting to establish radio communication with any vessel(s) besides the other vessel in the collision?

NO = 0

YES = 1

NO DATA = 9

- X.39 Did the person in charge of the primary vessel determine the stand-on and give-way vessel(s) for the potential collision threat(s)?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- X.40 Was the primary vessel the stand-on vessel?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- X.41 Did the primary vessel initiate an avoidance maneuver? Answer NO if did not maneuver until in extremis.
- NO = 0
 - YES = 1
 - NO DATA = 9
- X.42 Did the primary vessel initiate an avoidance maneuver at a distance of more than 5 nmi?
- NO = 0
 - YES = 1
 - NO DATA = 9
- X.43 Did the primary vessel initiate an avoidance maneuver at a distance of more than 3 to 5 nmi?
- NO = 0
 - YES = 1
 - NO DATA = 9
- X.44 Did the primary vessel initiate an avoidance maneuver at a distance of more than 2 to 3 nmi?
- NO = 0
 - YES = 1
 - NO DATA = 9
- X.45 Did the primary vessel initiate an avoidance maneuver at a distance of 1 to 2 nmi?
- NO = 0
 - YES = 1
 - NO DATA = 9

- X.46 Did the primary vessel initiate an avoidance maneuver at a distance of 1,000 to 2,000 yards?
- NO = 0
YES = 1
NO DATA = 9
- X.47 Did the primary vessel initiate an avoidance maneuver at a distance of less than 1,000 yards?
- NO = 0
YES = 1
NO DATA = 9
- X.48 If the primary vessel maneuvered, does the report indicate that the maneuver was appropriate/logical under the circumstances?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- X.49 Was speed change executed as ordered?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- X.50 Was course change executed as ordered?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- X.51 Was tug action as ordered? (Answer NA for unassisted tug/towboat-barge configuration.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

X.52 Was the primary vessel in the collision detected as a radar target?

NO = 0

YES = 1

NO DATA = 9

X.53 Was the primary vessel in the collision detected as a radar target prior to visual sighting?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.54 Was the primary vessel in the collision detected as a radar target at a distance of less than 1 mile?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.55 Was the primary vessel in the collision detected as a radar target at a distance of 1 to 2 miles?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.56 Was the primary vessel in the collision detected as a radar target at a distance of more than 2 miles to 5 miles?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.57 Was the primary vessel in the collision detected as a radar target at a distance of more than 5 miles?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.58 Was the primary vessel in the collision visually sighted by the person in charge of the other vessel at a distance of less than 1 mile?

NO = 0

YES = 1

NO DATA = 9

X.59 Was the primary vessel in the collision visually sighted by the person in charge of the other vessel at a distance of 1 to 2 miles?

NO = 0

YES = 1

NO DATA = 9

X.60 Was the primary vessel in the collision visually sighted by the person in charge of the other vessel at a distance of more than 2 miles to 5 miles?

NO = 0

YES = 1

NO DATA = 9

X.61 Was the primary vessel in the collision visually sighted by the person in charge of the other vessel at a distance of more than 5 miles?

NO = 0

YES = 1

NO DATA = 9

- X.62 Did the person in charge of the other vessel perceive the primary vessel to be a collision threat in time for avoidance?
- NO = 0
YES = 1
NO DATA = 9
- X.63 Did the person in charge of the other vessel perceive one or more other vessels (besides the one involved in this collision) to be a potential collision threat?
- NO = 0
YES = 1
NO DATA = 9
- X.64 Were the course and speed of the primary vessel in the collision determined by the person in charge of the other vessel?
- NO = 0
YES = 1
NO DATA = 9
- X.65 Were the CPA and TCPA of the primary vessel in the collision determined by the person in charge of the other vessel?
- NO = 0
YES = 1
NO DATA = 9
- X.66 Were the intentions of the primary vessel determined by visual observations?
- NO = 0
YES = 1
NO DATA = 9
- X.67 Were the intentions of the primary vessel determined by plotting?
- NO = 0
YES = 1
NO DATA = 9

X.68 Were the intentions of the primary vessel in the collision determined by radio communication?

NO = 0

YES = 1

NO DATA = 9

X.69 Did the other vessel attempt radio communication with the primary vessel?

NO = 0

YES = 1

NO DATA = 9

X.70 Were the course and speed of any additional vessels being determined by the person in charge of the other vessel?

NO = 0

YES = 1

NO DATA = 9

X.71 Were the CPA and TCPA of any additional vessels being determined by the person in charge of the other vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.72 Were the intentions of any additional vessels being determined by the person in charge of the other vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

X.73 Was the other vessel engaging in or attempting to establish radio communication with any vessel(s) besides the primary vessel in the collision?

NO = 0

YES = 1

NO DATA = 9

X.74 Did the person in charge of the other vessel determine the stand-on and give-way vessel(s) for the potential collision threat(s)?

NO = 0

YES = 1

NO DATA = 9

NA = 8

X.75 Was the other vessel the stand-on vessel?

NO = 0

YES = 1

NO DATA = 9

NA = 8

X.79-80 ENTER "10" IN COLUMNS 79 AND 80. THIS COMPLETES CARD X.

The following questions will be answered on Card XI.

XI.1-10 Duplicate the responses given on Card XI.

XI.11 Did the other vessel initiate an avoidance maneuver? (Answer NO if maneuver initiated in extremis.)

NO = 0

YES = 1

NO DATA = 9

XI.12 Did the other vessel initiate an avoidance maneuver at a distance of more than 5 nmi?

NO = 0

YES = 1

NO DATA = 9

XI.13 Did the other vessel initiate an avoidance maneuver at a distance of more than 3 to 5 nmi?

NO = 0

YES = 1

NO DATA = 9

XI.14 Did the other vessel initiate an avoidance maneuver at a distance of more than 2 to 3 nmi?

NO = 0

YES = 1

NO DATA = 9

XI.15 Did the other vessel initiate an avoidance maneuver at a distance of 1 to 2 nmi?

NO = 0

YES = 1

NO DATA = 9

XI.16 Did the other vessel initiate an avoidance maneuver at a distance of 1,000 to 2,000 yards?

NO = 0

YES = 1

NO DATA = 9

XI.17 Did the other vessel initiate an avoidance maneuver at a distance of less than 1,000 yards?

NO = 0

YES = 1

NO DATA = 9

XI.18 If the other vessel maneuvered, does the report indicate that the maneuver was appropriate/logical under the circumstances?

NO = 0

YES = 1

NA = 8

NO DATA = 9

XI.19 Was speed change executed as ordered?

NO = 0

YES = 1

NA = 8

NO DATA = 9

XI.20 Was course change executed as ordered?

NO = 0

YES = 1

NA = 8

NO DATA = 9

XI.21 Was tug action as ordered?

NO = 0

YES = 1

NA = 8

NO DATA = 9

XI.79-80 ENTER "11" IN COLUMNS 79 AND 80. THIS COMPLETES CARD XI.

The following questions will be answered on Card XII.

XII.1-10 Duplicate the responses given on Card I, Columns 1-10.

PART XIII: ANALYSIS OF CASUALTY-PRECIPITATING FACTORS

If any of the answers in columns 11 through 15 is YES, do not code the rest of this section.

XII.11 Was a "cataclysmic" event (e.g., vessels caught in a hurricane, sudden death/illness of helmsman or person in charge of either vessel, explosion, etc.) a factor in the casualty?

NO = 0

YES = 1

XII.12 Was an apparently irrational or irresponsible behavior in the conduct of vessel handling operations on the part of primary vessel personnel a factor in the casualty?

NO = 0

YES = 1

XII.13 Was an apparently irrational or irresponsible behavior in the conduct of vessel handling operations on the part of the other vessel personnel a factor in the casualty?

NO = 0

YES = 1

XII.14 Was equipment failure on the primary vessel such as to take away control capability (e.g., loss of steering, lines parted, etc.) a precipitating factor in the casualty? (Exclude failures/deficiencies of navigational instrumentation.)

NO = 0

YES = 1

XII.15 Was equipment failure on the other vessel, such as to take away control capability (e.g., loss of steering, lines parted, etc.) a precipitating factor in the casualty? (Exclude failures/deficiencies of navigational instrumentation.)

NO = 0

YES = 1

XII.16 Was failure or deficiency of navigational instrumentation on primary vessel a factor in the casualty?

NO = 0

YES = 1

XII.17 Was failure or deficiency of navigational instrumentation on the other vessel a factor in the casualty?

NO = 0

YES = 1

- XII.18 Was the effect of a current phenomenon on the maneuvering of the primary vessel a factor in the casualty?
NO = 0
YES = 1
- XII.19 Was the effect of a current phenomenon on the maneuvering of the other vessel a factor in the casualty?
NO = 0
YES = 1
- XII.20 Was the effect of a wind phenomenon on the maneuvering of the primary vessel a factor in the casualty?
NO = 0
YES = 1
- XII.21 Was the effect of a wind phenomenon on the maneuvering of the other vessel a factor in the casualty?
NO = 0
YES = 1
- XII.22 Was the effect of the tidal condition on the maneuvering of the primary vessel in that it restricted the options available a factor in the casualty?
NO = 0
YES = 1
- XII.23 Was the effect of the tidal condition on the maneuvering of the other vessel in that it restricted the options available a factor in the casualty?
NO = 0
YES = 1
- XII.24 Was a malfunctioning aid to navigation a factor in the casualty?
(Include buoys off station, light out, etc.)
NO = 0
YES = 1
- XII.25 Was ice or an ice field a factor in the casualty by affecting the maneuvering of either or both vessels?
NO = 0
YES = 1

- XII.26 Was one or more other vessel(s) a factor in the casualty? (Exclude assisting vessels; exclude the other vessel in the collision.)
- NO = 0
YES = 1
- XII.27 Was some other floating object a factor in the casualty (other than an aid to navigation, ice, or another vessel)?
- NO = 0
YES = 1
- XII.28 Was a submerged object a factor in the casualty?
- NO = 0
YES = 1
- XII.29 Was a fixed structure or object in the water, other than an aid to navigation (e.g., bridge, pier, piling) a factor in the casualty?
- NO = 0
YES = 1
- XII.30 Was shallow water a factor in the casualty by affecting the maneuvering of the primary vessel?
- NO = 0
YES = 1
- XII.31 Was shallow water a factor in the casualty by affecting the maneuvering of the other vessel?
- NO = 0
YES = 1

- XII.32 Was some other physical hazard not covered by columns 25-33 a factor in the casualty?
NO = 0
YES = 1
- XII.33 Was failure in the execution of navigational order(s) a precipitating factor in the casualty (where the failure was not the result of equipment failure)? Answer for the primary vessel/vessel configuration.
NO = 0
YES = 1
- XII.34 Was failure in the execution of navigational order(s) a precipitating factor in the casualty (where the failure was not the result of equipment failure)? Answer for the other vessel/vessel configuration.
NO = 0
YES = 1
- XII.35 Was the inability to interpret radar target(s) on the part of primary vessel personnel a factor in the casualty?
NO = 0
YES = 1
- XII.36 Was the inability to interpret radar target(s) on the part of the other vessel personnel a factor in the casualty?
NO = 0
YES = 1
- XII.37 Was late detection of the other vessel on the part of the primary vessel a precipitating factor in the casualty?
NO = 0
YES = 1
- XII.38 Was late detection of the primary vessel on the part of the other vessel a precipitating factor in the casualty?
NO = 0
YES = 1

XII.39 Was the casualty occurrence associated with a condition of the primary vessel such that it was not easy to detect or monitor?

NO = 0

YES = 1

XII.40 Was the casualty occurrence associated with a condition of the other vessel such that it was not easy to detect or monitor?

NO = 0

YES = 1

XII.41 Was the casualty occurrence associated with some design or loading characteristic of the primary vessel such that the view of the person in charge was obstructed?

NO = 0

YES = 1

XII.42 Was the casualty occurrence associated with some design or loading characteristic of the other vessel such that the view of the person in charge was obstructed?

NO = 0

YES = 1

XII.43 Was an obscuring condition of the natural environment (e.g., rain, snow, fog, twilight, heavy sea return, shore lights, hazard hidden behind bend, etc.) a factor in the casualty?

NO = 0

YES = 1

- XII.44 Was failure on the part of one or both vessels to perceive the other as a collision threat a precipitating factor in the casualty?
- NO = 0
YES = 1
- XII.45 Was failure of the person in charge of the primary vessel to evaluate the situation and decide on appropriate action in time a precipitating factor in the casualty? (Answer NO if he did not detect the other vessel or did not recognize the collision threat in time to avoid. Answer NO if the other vessel maneuvered in an unorthodox manner at close range and/or maneuvering constraints on the primary vessel were such that there was nothing it could do to avoid the casualty.)
- NO = 0
YES = 1
- XII.46 Was failure of the person in charge of the other vessel to evaluate the situation and decide on appropriate action in time a precipitating factor in the casualty? (Answer NO if he did not detect the primary vessel or did not recognize the collision threat in time to avoid. Answer NO if the primary vessel maneuvered in an unorthodox manner at close range and/or maneuvering constraints on the other vessel were such that there was nothing it could do to avoid the casualty.)
- NO = 0
YES = 1
- XII.47 Did the casualty occur in a complex situation—i.e., a situation in which avoidance options were limited because of other nearby hazards, or by control requirements (e.g., necessity to maintain speed in a strong current)?
- NO = 0
YES = 1
- XII.48 Does it appear that primary vessel personnel did not establish the position and/or monitor the movement of the other vessel closely enough although it was detected in time for avoidance?
- NO = 0
YES = 1
- XII.49 Does it appear that other vessel personnel did not establish the position and/or monitor the movement of the primary vessel closely enough although it was detected in time for avoidance?
- NO = 0
YES = 1

- XII.50 Was failure of the primary vessel to properly establish own navigational position prior to the casualty a precipitating factor?
- NO = 0
YES = 1
- XII.51 Was failure of the other vessel to properly establish own navigational position prior to the casualty a precipitating factor?
- NO = 0
YES = 1
- XII.52 Was error or delay in plotting on the part of the primary vessel personnel a factor in the casualty?
- NO = 0
YES = 1
- XII.53 Was error or delay in plotting on the part of the other vessel personnel a factor in the casualty?
- NO = 0
YES = 1
- XII.54 Was the primary vessel in an unusual or inappropriate location prior to the casualty (wrong side or outside of channel)?
- NO = 0
YES = 1
- XII.55 Was the other vessel in an unusual or inappropriate location prior to the casualty (wrong side or outside of channel)?
- NO = 0
YES = 1
- XII.56 Was the casualty occurrence associated with a communications problem related to language barrier on the primary vessel or within the primary vessel configuration?
- NO = 0
YES = 1
- XII.57 Was the casualty occurrence associated with a communications problem related to language barrier on the other vessel or within the other vessel configuration?
- NO = 0
YES = 1

XII.58 Was the casualty occurrence associated with failure in communications between the primary vessel and its assisting vessel(s)? (Include communications between towing vessels in a tug/towboat-barge configuration.)

NO = 0

YES = 1

XII.59 Was the casualty occurrence associated with failure in communications between the other vessel and its assisting vessel(s)? (Include communications between towing vessels in a tug/towboat-barge configuration.)

NO = 0

YES = 1

XII.60 Was a communication problem between the colliding vessels a factor in the casualty? (Either poor communication or no communication.)

NO = 0

YES = 1

If answer is NO, go to question 73.

XII.61 Did the primary vessel fail to attempt or return bridge-to-bridge radio communication with the other vessel in time to take avoidance actions?

NO = 0

YES = 1

XII.62 Did the other vessel fail to attempt or return bridge-to-bridge radio communication with the primary vessel in time to take avoidance actions?

NO = 0

YES = 1

If the answers to BOTH 61 and 62 are YES, go to question 66.

XII.63 Did the colliding vessels fail to establish bridge-to-bridge radio communication?

NO = 0

YES = 1

XII.64 Did either vessel communicate with the wrong vessel, mistaking its identity?

NO = 0

YES = 1

XII.65 Did the bridge-to-bridge communication fail to provide accurate, precise information about the position and intentions of both vessels?

NO = 0

YES = 1

XII.66 Did the primary vessel fail to attempt whistle signals to establish a passing agreement with the other vessel in time to take avoidance actions?

NO = 0

YES = 1

XII.67 Did the other vessel fail to attempt whistle signals to establish a passing agreement with the primary vessel in time to take avoidance actions?

NO = 0

YES = 1

If the answers to 61, 62, 66, and 67 are ALL YES, go to question 73, i.e., if there was no communication between the colliding vessels in time to avoid the collision, go to question 73.

XII.68 Did the vessel to which the whistle signal was directed fail to respond?

NO = 0

YES = 1

In coding questions 69 and 70, only one may be answered YES.

XII.69 Was there a lack of common understanding concerning the passing agreement (either whistles or bridge-to-bridge radio) by the persons in charge of the vessels?

NO = 0

YES = 1

XII.70 Was the passing agreement achieved an illogical or inappropriate agreement?

NO = 0

YES = 1

XII.71 Was the attempted passing agreement obscured by distractions or operating conditions onboard the responding vessel?

NO = 0

YES = 1

XII.72 Did either vessel proceed in an unexpected manner after the passing agreement had been made?

NO = 0

YES = 1

XII.73 Was failure of the primary vessel to maintain position prior to the casualty a precipitating factor?

NO = 0

YES = 1

XII.74 Was failure of the other vessel to maintain position prior to the casualty a precipitating factor?

NO = 0

YES = 1

XII.75 Was the casualty occurrence associated with a distraction onboard the primary vessel (or within the primary vessel configuration) such as a problem with a towing line, something lost over the side, a fire, a fight, someone injured, etc.?

NO = 0

YES = 1

XII.76 Was the casualty occurrence associated with a distraction onboard the other vessel (or within the other vessel configuration) such as a problem with a towing line, something lost over the side, a fire, a fight, someone injured, etc.?

NO = 0

YES = 1

XII.79-80 ENTER "12" IN COLUMNS 79 and 80. THIS COMPLETES CARD XII.

XIII.1-10 Duplicate the responses given on Card I, Columns 1-10.

XIII.11 Was the casualty occurrence associated with distraction of the primary vessel personnel by some condition or event in the operating environment (e.g., one or more vessels being encountered, some kind of emergency not involving own vessel, construction operations nearby, etc.)?

NO = 0

YES = 1

XIII.12 Was the casualty occurrence associated with distraction of the other vessel personnel by some condition or event in the operating environment (e.g., one or more vessels being encountered, some kind of accident or emergency not involving own vessel, construction operations nearby, etc.)?

NO = 0

YES = 1

XIII.13 Was the casualty occurrence associated with primary vessel personnel involvement in tasks or activities not directly related to vessel control (personnel who were supposedly involved in vessel control)?

NO = 0

YES = 1

XIII.14 Was the casualty occurrence associated with other vessel personnel involvement in tasks or activities not directly related to vessel control (personnel who were supposedly involved in vessel control)?

NO = 0

YES = 1

- XIII.15 Does the report indicate that the casualty occurrence was associated with insufficient personnel training/experience?
- NO = 0
YES = 1
- XIII.16 Does the report indicate that lack of knowledge of the governing Rules and/or standard local practice in vessel encounters was a factor in the casualty?
- NO = 0
YES = 1
- XIII.17 Was lack of knowledge of the vessel's handling characteristics on the part of the person in charge of the primary vessel a contributing factor (rate of turn, radius turn, time to effect a speed change after command given, effect of wind or current, etc.)?
- NO = 0
YES = 1
- XIII.18 Was lack of knowledge of the vessel's handling characteristics on the part of the person in charge of the other vessel a contributing factor (rate of turn, radius turn, time to effect a speed change after command given, effect of wind or current, etc.)?
- NO = 0
YES = 1
- XIII.19 Does the report indicate that speed was a factor in the casualty?
- NO = 0
YES = 1
NO DATA = 9
- XIII.20 Does the report indicate that inadequate tug/towboat assistance was a factor in the casualty (i.e., not enough assisting vessels, insufficient horsepower, assisting vessels not available or not used when needed)?
- NO = 0
YES = 1
NO DATA = 9

XIII.21 Did the estimated total damage exceed \$1,000?

NO = 0

YES = 1

NO DATA = 9

XIII.22 Did the estimated total damage exceed \$30,000?

NO = 0

YES = 1

NO DATA = 9

XIII.23 Was there any loss of life or serious injury as a result of this casualty? (Serious injury means incapacitation for more than 72 hours.)

NO = 0

YES = 1

NO DATA = 9

XIII.24 Was the person found at fault by the Coast Guard an unlicensed person?

NO = 0

YES = 1

NA = 8

NO DATA = 9

XIII.79-80 ENTER "13" IN COLUMNS 79 and 80. THIS COMPLETES CARD XIII.

HARBOR CASUALTY ANALYSIS GAUGE FOR GROUNDING,
COLLISION WITH A NON-VESSEL AND COLLISION WITH A
VESSEL ANCHORED, MOORED, OR ADRIFT

NOTE: The Roman numeral indicates the card number; the decimal number indicates the column number on the coding sheet.

PART I: CASE IDENTIFICATION

I.1-5 Enter the 5-digit case serial number shown on the report.

I.6 Was this casualty a grounding?

NO = 0

YES = 1

I.7 Was this casualty a collision of a vessel under power with a non-vessel? (Consider a vessel being assisted in moving by tugboat(s) or towboat(s) under power.)

NO = 0

YES = 1

I.8 Was this casualty a collision of a vessel under power with a vessel anchored/moored, otherwise not moving (e.g., grounded), or adrift? (Consider a vessel being assisted in moving by tugboat(s) or towboat(s) under power.)

NO = 0

YES = 1

If the answers in columns 6-8 is NO, stop. Save the partly completed CAG and go on to another report.

I.9 Was the vessel that ran aground, or the striking vessel in collision cases, a ship greater than 10,000 GRT?

NO = 0

YES = 1

I.10 Was the vessel that ran aground, or the striking vessel in collision cases, a tug/towboat-barge array?

NO = 0

YES = 1

If the answer in both columns 9 and 10 is NO, stop. Save the partly completed CAG and go on to another report.

I.11-12 Year of casualty (1971 = 71, 1972 = 72, etc.).

I.13-14 Month of casualty (Jan = 01, Feb = 02, etc.).

If the casualty did not occur during the period June 1971 through October 1976, stop. Save the partly completed CAG and go on to another report.

I.15 Type of report.

Marine Board = 1

Narrative = 2

Letter of transmittal = 3
with no significant
data beyond that on
269

Letter of transmittal = 4
with significant data

PART II: DESCRIPTION OF THE PRIMARY VESSEL

Definition:

- a. The primary vessel is a ship of 10,000 GRT or more, or a tug/towboat-barge array.
- b. If two such vessels were involved in the casualty, the striking vessel is the primary vessel.

In coding columns 16-21, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.)

I.16 Was the primary vessel a tank ship?

NO = 0

YES = 1

NO DATA = 9

I.17 Was the primary vessel a cargo ship?

NO = 0

YES = 1

NO DATA = 9

I.18 Was the primary vessel a passenger ship?

NO = 0

YES = 1

NO DATA = 9

I.19 Was the primary vessel a tank barge or an array of tank barges?

NO = 0

YES = 1

NO DATA = 9

I.20 Was the primary vessel a general purpose cargo barge/barge array?

NO = 0

YES = 1

NO DATA = 9

I.21 Was the primary vessel a tug/towboat-barge array not otherwise classified?

NO = 0

YES = 1

NO DATA = 9

If none of the answers in columns 16-21 is YES, stop. Save the partly completed CAG and go on to another report.

I.22 Was the primary vessel being assisted by one or more tugboats or towboats? (Answer YES if they were in the process of engaging or disengaging.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 23-25, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.23 If the primary vessel was assisted, was there just one assisting vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.24 If the primary vessel was assisted, were there two assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.25 If the primary vessel was assisted, were there three or more assisting vessels?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.26 Were tugs (one or more) standing by?

NO = 0

YES = 1

NO DATA = 9

In coding columns 27-31, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.27 If the primary vessel was a barge or barge array, was there just one barge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.28 If the primary vessel was a barge array, were there two or three barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.29 If the primary vessel was a barge array, were there four or five barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.30 If the primary vessel was a barge array, were there six to 10 barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.31 If the primary vessel was a barge array, were there more than 10 barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 32-34, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.32 If the primary vessel was a barge array, was there just one barge across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.33 If the primary vessel was a barge array, were there two across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.34 If the primary vessel was a barge array, were there three or more across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.35 If the primary vessel was a barge or barge array, was it being pulled at the end of the hawser?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.36 If the primary vessel was a barge or barge array, was it being pushed from astern?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.37 If the primary vessel was a barge or barge array, was the towing vessel (or vessels) alongside?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.38 If the primary vessel was a barge or barge array, was it an integrated tug-barge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.39 If the primary vessel was a barge or barge array, was it in a loaded condition?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.40 If the primary vessel was a barge or barge array, was it empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.41 If the primary vessel was a barge array, were some barges loaded and some empty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.42 If the primary vessel was a barge or barge array, was its movement a one-man operation (i.e., a single assisting vessel with a single operator)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.43 If the primary vessel was a barge or barge array, was it a Western Rivers type towboat-barge configuration?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 44 and 45, NO DATA is valid only if both questions are answered NO DATA. Only one may be answered YES.

I.44 If the primary vessel was a ship, was it carrying cargo?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.45 If the primary vessel was a ship, was it in ballast?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.46 If the primary vessel was moving with assistance, was it using on-board propulsive units as well? (Answer NA if the primary vessel was a barge or barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.47 If the primary vessel was moving with assistance, did the assisting vessel (or vessels) have lateral thrusters or CP propellers?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.48 If the primary vessel was moving without assistance, did it have lateral thrusters or CP propellers?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 49-51, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.49 If the primary vessel was a ship, was the bridge located forward?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.50 If the primary vessel was a ship, was the bridge located midships?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.51 If the primary vessel was a ship, was the bridge located aft?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 52-54, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.52 The vessel tonnage was 10,000 GRT or less. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

I.53 The vessel tonnage was more than 10,000 GRT to 15,000 GRT. (For barge arrays, take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

I.54 The vessel tonnage was more than 15,000 GRT. (For barge arrays take the total gross tonnage.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 55-59, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.55 The vessel length was less than 100 feet. (For barge arrays take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.56 The vessel length was 100 feet to less than 300 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.57 The vessel length was 300 feet to less than 500 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.58 The vessel length was 500 feet to less than 700 feet. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

I.59 The vessel length was 700 feet or more. (For barge arrays, take the total length, excluding tug/towboat and hawser, if any.)

NO = 0

YES = 1

NO DATA = 9

In coding columns 60-62, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.60 If the barge/barge array was being pulled at the end of a hawser, the hawser length was less than 300 feet.

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.61 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 300 feet to less than 600 feet.

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.62 If the barge/barge array was being pulled at the end of a hawser, the hawser length was 600 feet or more.

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 63-66, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

I.63 The vessel's under keel clearance prior to the casualty was less than 1 foot.

NO = 0

YES = 1

NO DATA = 9

I.64 The vessel's under keel clearance prior to the casualty was 1 foot to less than 2 feet.

NO = 0

YES = 1

NO DATA = 9

I.65 The vessel's under keel clearance prior to the casualty was 2 feet to less than 4 feet.

NO = 0

YES = 1

NO DATA = 9

I.66 The vessel's under keel clearance prior to the casualty was 4 feet or more.

NO = 0

YES = 1

NO DATA = 9

I.67 Did the vessel have just one propeller? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)

NO = 0

YES = 1

NO DATA = 9

I.68 Did the vessel have two propellers? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)

NO = 0

YES = 1

NO DATA = 9

- I.69 Did the vessel have just one rudder? (If the vessel was a barge/ barge array under tow, answer for the tug/towboat.)
NO = 0
YES = 1
NO DATA = 9
- I.70 Did the vessel have two rudders? (If the vessel was a barge/barge array under tow, answer for the tug/towboat.)
NO = 0
YES = 1
NO DATA = 9
- I.71 If the vessel was a barge/barge array under tow, did the tug/towboat have a flanking rudder?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- I.72 Was the rudder capable of going 35 deg. on either side of midships? (If the primary vessel was a barge/barge array under tow, answer for the tug/towboat.)
NO = 0
YES = 1
NO DATA = 9
- I.73 Was the rudder capable of going more than 35 deg. on either side of midships? (If the primary vessel was a barge/barge array under tow, answer for the tug/towboat.)
NO = 0
YES = 1
NO DATA = 9
- I.74 If the vessel was a ship, was there bridge control of the main propulsion system?
NO = 0
YES = 1
NA = 8
NO DATA = 9

I.75 If the vessel was a ship, was the main propulsion system steam?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.76 If the vessel was a ship, was the main propulsion system diesel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.77 If the vessel was a ship, was the main propulsion system gas turbine?

NO = 0

YES = 1

NA = 8

NO DATA = 9

I.80 ENTER "1" IN COLUMN 80. THIS COMPLETES CARD 1.

The following questions will be answered on Card 2.

II.1-10 Duplicate the responses given on Card 1, Columns 1 through 10.

II.11 Was the primary vessel a U.S. vessel?

NO = 0

YES = 1

NO DATA = 9

II.12 Was the primary vessel foreign registered?

NO = 0

YES = 1

NO DATA = 9

II.13 Was the primary vessel inspected by the U.S. Coast Guard?

NO = 0

YES = 1

NO DATA = 9

PART III: DESCRIPTION OF THE OTHER VESSEL

If the case is a grounding or a collision with a non-vessel, answer all questions in this section NA.

In coding columns 14-22, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.14 Was the other vessel a ship of 10,000 GRT or more?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.15 Was the other vessel a ship of less than 10,000 GRT?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.16 Was the other vessel a barge or an array of barges?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.17 Was the other vessel a service vessel such as a crew or supply boat, pilot boat, tender, or a tug/towboat?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.18 Was the other vessel a construction, wrecking, or other special-purpose vessel (include pipelaying barge, dredge, pile-driver, drilling unit, etc.)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.19 Was the other vessel a passenger vessel or ferry?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.20 Was the other vessel a commercial fishing vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.21 Was the other vessel a recreational boat?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.22 Was the other vessel another kind of vessel not covered in columns 14-21?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 23-27, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.23 If the other vessel was a barge or barge array, was there just one barge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.24 If the other vessel was a barge array, were there two or three barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.25 If the other vessel was a barge array, were there four or five barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.26 If the other vessel was a barge array, were there six to 10 barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.27 If the other vessel was a barge array, were there more than 10 barges in the array?

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 28-30, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.28 If the other vessel was a barge array, was there just one barge across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.29 If the other vessel was a barge array, were there two across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.30 If the other vessel was a barge array, were there three or more across? (Answer NA if there was just one barge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 31-35, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.)

II.31 The other vessel length was less than 100 feet. (For barge arrays take the total length.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.32 The other vessel length was 100 feet to less than 300 feet. (For barge arrays take the total length.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.33 The other vessel length was 300 feet to less than 500 feet. (For barge arrays take the total length.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.34 The other vessel length was 500 feet to less than 700 feet. (For barge arrays take the total length.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

- II.35 The other vessel length was 700 feet or more. (For barge arrays take the total length.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- II.36 Was the other vessel a U.S. vessel?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- II.37 Was the other vessel foreign registered?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- II.38 Was the other vessel inspected by the U.S. Coast Guard?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- II.39 Had the other (the struck) vessel drifted from its moored/anchored position?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- II.40 Was the struck vessel anchored/moored or otherwise stopped in an improper or unusual location?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

II.41 Was the struck vessel in an emergency condition (e.g., foundered, capsized, swamped, etc.)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

II.42 Was the struck vessel properly lighted or displaying other warning signals as appropriate? Answer "yes" unless otherwise specified.

NO = 0

YES = 1

NA = 8

II.43 If the struck vessel was in an unusual circumstance (in an emergency or stopped in an improper/unusual location) had a radio advisory been given by official sources?

NO = 0

YES = 1

NA = 8

NO DATA = 9

PART IV: NATURE OF THE STRUCK OBJECT (OTHER THAN A VESSEL)

Answer all of the questions in this section NA if the casualty was a grounding or a collision with another vessel.

In coding columns 44-48, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.44 Was the collision with an aid to navigation (fixed or floating)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

- II.45 Was the collision with a fixed object (structure) other than an aid to navigation, such as a bridge pier, dike, dock, offshore platform or drilling unit on station?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- II.46 Was the collision with ice or an ice field?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- II.47 Was the collision with a floating object not otherwise classified?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- II.48 Was the collision with a submerged object?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- II.49 Was the struck object lighted or its presence indicated by some other kind of warning signal? (Answer NA for collisions with ice, and collisions that occurred during docking maneuvers.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- II.50 Was the presence of the hazard indicated by the navigational charts and/or publications for the area? (Answer NA if collision occurred during docking maneuver.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

II.51 Had a radio advisory been given by official sources as to the presence or hazardous condition of the struck object? (Answer NA if occurred during docking maneuvers.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

PART V: VARIABLE ENVIRONMENTAL CONDITIONS

In coding columns 52-56, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.52 At the time of the casualty, visibility was less than 1/4 mile. (Answer YES if any dense fog.)

NO = 0

YES = 1

NO DATA = 9

II.53 Visibility was $\frac{1}{4}$ to less than $\frac{1}{2}$ mile.

NO = 0

YES = 1

NO DATA = 9

II.54 Visibility was $\frac{1}{2}$ to less than 1 mile.

NO = 0

YES = 1

NO DATA = 9

II.55 Visibility was 1 to 2 miles.

NO = 0

YES = 1

NO DATA = 9

II.56 Visibility was greater than 2 miles. (Answer YES if visibility clear or unlimited.)

NO = 0

YES = 1

NO DATA = 9

II.57 Did the vessel(s) encounter a sudden change in visibility shortly before the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

In coding columns 58-63, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.58 At the time of the casualty, the wind was 0 to 3 knots.

NO = 0

YES = 1

NO DATA = 9

II.59 The wind speed was 4 to 10 knots.

NO = 0

YES = 1

NO DATA = 9

II.60 The wind speed was 11 to 16 knots.

NO = 0

YES = 1

NO DATA = 9

II.61 The wind speed was 17 to 27 knots.

NO = 0

YES = 1

NO DATA = 9

II.62 The wind speed was 28 to 40 knots.

NO = 0

YES = 1

NO DATA = 9

II.63 The wind speed was greater than 40 knots.

NO = 0

YES = 1

NO DATA = 9

In coding columns 64-68, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.64 The wind direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.65 The wind direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.66 The wind direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

II.67 The wind direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

II.68 The wind direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

In coding columns 69-73, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.69 At the time of the casualty, the sea was calm (0-4 foot swell).

NO = 0

YES = 1

NO DATA = 9

II.70 The sea swell was 5 to 15 feet.

NO = 0

YES = 1

NO DATA = 9

II.71 The sea swell was 16 to 20 feet.

NO = 0

YES = 1

NO DATA = 9

II.72 The sea swell was 21 to 40 feet.

NO = 0

YES = 1

NO DATA = 9

II.73 The sea swell was greater than 40 feet.

NO = 0

YES = 1

NO DATA = 9

In coding columns 74-78, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

II.74 The wave direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.75 The wave direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

II.76 The wave direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

II.77 The wave direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

II.78 The wave direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

II.80 ENTER "2" IN COLUMN 80. THIS COMPLETES CARD 2.

The following questions will be answered on Card 3.

III.1-10 Duplicate the responses given on Card 1, Columns 1 through 10.

In coding columns 11-13, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.11 At the time of the casualty, the current speed was less than 1 knot.

NO = 0

YES = 1

NO DATA = 9

III.12 The current speed was 1 to 2 knots.

NO = 0

YES = 1

NO DATA = 9

III.13 The current speed was greater than 2 knots.

NO = 0

YES = 1

NO DATA = 9

In coding columns 14-18, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.14 The current direction relative to ship's center line was parallel with ship's direction.

NO = 0

YES = 1

NO DATA = 9

III.15 The current direction relative to ship's center line was parallel against ship's direction.

NO = 0

YES = 1

NO DATA = 9

III.16 The current direction relative to ship's center line was perpendicular.

NO = 0

YES = 1

NO DATA = 9

III.17 The current direction was broad on bow.

NO = 0

YES = 1

NO DATA = 9

III.18 The current direction was broad on quarter.

NO = 0

YES = 1

NO DATA = 9

In coding columns 19-22, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.19 At the time of the casualty, the tidal condition was high water (slack).

NO = 0

YES = 1

NO DATA = 9

III.20 The tidal condition was low water (slack).

NO = 0

YES = 1

NO DATA = 9

III.21 The tide was flooding.

NO = 0

YES = 1

NO DATA = 9

III.22 The tide was ebbing.

NO = 0

YES = 1

NO DATA = 9

III.23 Did the vessel(s) encounter a sudden change in wind, current, and/or tide action shortly before the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 24-26, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.24 The casualty occurred during the day.

NO = 0

YES = 1

NO DATA = 9

III.25 The casualty occurred at night.

NO = 0

YES = 1

NO DATA = 9

III.26 The casualty occurred at twilight (dawn or dusk).

NO = 0

YES = 1

NO DATA = 9

PART VI: GEOPHYSICAL AND OTHER AREA CHARACTERISTICS

In coding columns 27-30, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer NO to docking situations.

III.27 Did the casualty occur in a fairly smooth (straight) deep draft channel?

NO = 0

YES = 1

NO DATA = 9

III.28 Did the casualty occur in a channel in which a course change is required?

NO = 0

YES = 1

NO DATA = 9

III.29 Did the casualty occur in a channel in which multiple course changes were required?

NO = 0

YES = 1

NO DATA = 9

III.30 Did the casualty occur in an area essentially unrestricted (in terms of geophysical boundaries), e.g., in a broad open bay, harbor, sound?

NO = 0

YES = 1

NO DATA = 9

In coding columns 31-35, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.31 In the area of the casualty, the channel width was less than 2 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.32 The channel width was 2 to 3 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.33 The channel width was between 3 and 4 times the primary vessel beam. (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.34 The channel width was more than 4 times the primary vessel beam.
(Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.35 If the casualty occurred in a deep draft channel, were there channel banks? (Answer NA if the casualty occurred in a nonrestricted area.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 36-39, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

III.36 The casualty occurred in a one-way, controlled channel.

NO = 0

YES = 1

NO DATA = 9

III.37 In the area where the casualty occurred, there was only parallel traffic (i.e., meetings and overtakings).

NO = 0

YES = 1

NO DATA = 9

III.38 In the area where the casualty occurred, there was crossing traffic, but limited to one or a few specific locations.

NO = 0

YES = 1

NO DATA = 9

III.39 In the area where the casualty occurred, the traffic pattern was random.

NO = 0

YES = 1

NO DATA = 9

In coding columns 40-43, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES. Answer NA if the casualty occurred in a one-way, controlled channel. Struck vessel not included.

III.40 The casualty occurred when there was no other vessel in the vicinity of the primary vessel.

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.41 The casualty occurred when there was only one other vessel in the vicinity of the primary vessel.

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.42 The casualty occurred when there were two to five other vessels in the vicinity of the primary vessel.

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.43 The casualty occurred when there were more than five other vessels in the vicinity of the primary vessel.

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.44 Was one or more of the other vessels in the vicinity underway?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.45 Was one or more of the vessels a potential collision threat (i.e., seen by the person in charge as a vessel whose movement must be monitored)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.46 At the time of the casualty, there were recreational boats in the vicinity. (Answer NA if the casualty occurred in a one-way, controlled channel.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.47 At the time of the casualty, there were commercial fishing vessels in the vicinity. (Answer NA if the casualty occurred in a one-way, controlled channel.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.48 Was there LORAN, DECCA, or OMEGA service in the area?

NO = 0

YES = 1

NO DATA = 9

PART VII: SCENARIO OF PRIMARY VESSEL OPERATIONS PRIOR TO THE CASUALTY

In coding columns 52-56, NO DATA is valid only if all questions are answered NO DATA.

III.49 At the time of the casualty, was the primary vessel in the process of engaging or disengaging with assisting vessel(s)?

NO = 0

YES = 1

NO DATA = 9

III.50 Was the primary vessel in the process of anchoring or disengaging anchor?

NO = 0

YES = 1

NO DATA = 9

III.51 Was the primary vessel in the process of mooring or unmooring?

NO = 0

YES = 1

NO DATA = 9

III.52 Was the primary vessel just passing by (not entering or exiting a port)?

NO = 0

YES = 1

NO DATA = 9

III.53 Was the primary vessel inbound?

NO = 0

YES = 1

NO DATA = 9

III.54 Was the primary vessel outbound?

NO = 0

YES = 1

NO DATA = 9

III.55 Was the primary vessel passing through port?

NO = 0

YES = 1

NO DATA = 9

III.56 Was the primary vessel making an intra-port move?

NO = 0

YES = 1

NO DATA = 9

III.57 Was the vessel negotiating a bridge or lock when the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

III.58 If the vessel was negotiating a bridge, was it a drawbridge?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.59 Was the vessel negotiating a sharp turn (more than 20 deg.) when the casualty occurred?

NO = 0

YES = 1

NO DATA = 9

III.60 If the vessel was a tug/towboat-barge configuration, had it been intentionally set aground just prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.61 Had there been a delay of 2 hours or more in the scheduled movement of the vessel?

NO = 0

YES = 1

NO DATA = 9

11. The first of the three is a simple case (see 11.1) and is easily handled.

11.1. $\alpha = 1$
11.2. $\alpha = 2$
11.3. $\alpha = 3$

11.4. The second of the three is a more complicated case (see 11.4) and is more difficult to handle.

11.4.1. $\alpha = 1$
11.4.2. $\alpha = 2$
11.4.3. $\alpha = 3$

11.5. The third of the three is a very complicated case (see 11.5) and is very difficult to handle.

11.5.1. $\alpha = 1$
11.5.2. $\alpha = 2$
11.5.3. $\alpha = 3$

- III.62 Did the person directing vessel handling operations have a federal pilot's license?
- NO = 0
YES = 1
NO DATA = 9
- III.63 Did the person directing vessel handling operations have a state pilot's license?
- NO = 0
YES = 1
NO DATA = 9
- III.64 Did the person directing vessel handling operations have some other kind of license pertinent to vessel handling?
- NO = 0
YES = 1
NO DATA = 9
- III.65 Was the person directing vessel handling operations a special, consulting pilot (not among the regular vessel personnel; someone who comes aboard to guide the vessel in the port area)?
- NO = 0
YES = 1
NO DATA = 9
- III.66 Was the person directing vessel handling a docking pilot (a specialist in directing docking/mooring maneuvers)?
- NO = 0
YES = 1
NO DATA = 9
- III.67 Did the special consulting pilot and any assisting vessel(s) come from a common organization? (Answer NA if there were no assisting vessels and/or no special, consulting pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

III.68 Was the master directing vessel handling operations?

NO = 0

YES = 1

NO DATA = 9

III.69 Was the mate on watch directing vessel handling operations? (Include "pilot" of a tug/towboat; this pilot is among the regular tug/towboat personnel and is second in command to the master/captain).

NO = 0

YES = 1

NO DATA = 9

III.70 Was someone else directing vessel handling operations?

NO = 0

YES = 1

NO DATA = 9

III.71 If a special, consulting pilot was directing the vessel handling operations, was the master present?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.72 If a special, consulting pilot was directing vessel handling operations, did the master take over?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.73 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a land pilot station or the home office?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.74 If a special, consulting pilot was directing vessel handling operations, had he come aboard from a pilot boat?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.75 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.76 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 8 to 16-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.77 If a special, consulting pilot was directing vessel handling operations, had he sailed with another vessel during the 17 to 24-hour period prior to boarding this vessel?

NO = 0

YES = 1

NA = 8

NO DATA = 9

III.80 ENTER "3" IN COLUMN 80. THIS COMPLETES CARD 3.

The following questions will be answered on Card 4.

IV.1-10 Duplicate the responses given on Card 1, Columns 1 through 10.

For the following questions to be coded in columns 11-29, "person in charge" is defined as the person directing vessel handling operations. If the primary vessel is a tug/towboat barge array, the tug/towboat captain is the person in charge.

In coding columns 11-15, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IV.11 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for less than 1 hour.

NO = 0

YES = 1

NO DATA = 9

IV.12 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 1 to 4 hours.

NO = 0

YES = 1

NO DATA = 9

IV.13 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 5 to 8 hours.

NO = 0

YES = 1

NO DATA = 9

IV.14 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for 9 to 12 hours.

NO = 0

YES = 1

NO DATA = 9

IV.15 At the time of the casualty, the person in charge had been directing vessel handling operations continuously for more than 12 hours.

NO = 0

YES = 1

NO DATA = 9

In coding columns 16-20, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

IV.16 At the time of the casualty, the person in charge had been continuously onboard between 1 and 10 days. (Answer NA if the vessel was a ship with a pilot in charge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.17 The person in charge had been continuously onboard for 11 to 30 days. (Answer NA if the vessel was a ship with a pilot in charge.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

- IV.18 The person in charge had been continuously onboard for 31 to 60 days.
(Answer NA if the vessel was a ship with a pilot in charge.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.19 The person in charge had been continuously onboard for 61 to 90 days.
(Answer NA if the vessel was a ship with a pilot in charge.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.20 The person in charge had been continuously onboard for more than
90 days. (Answer NA if the vessel was a ship with a pilot in charge.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.21 If the master or mate was in charge did he have in-port duties prior
to departure or did he have other non-watchstanding duties prior to
in-bound transit? (Include tug/towboat captain/pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

In coding columns 22-25, NO DATA is valid only if all of the questions are
answered NO DATA. Only one may be answered YES.

- IV.22 If the master or mate on watch had prior duties with no break, was
he working 2 hours or less before taking charge of vessel handling
operations? (Include tug/towboat captain/pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9

- IV.23 If the master or mate on watch had prior duties with no break, was he working 3 to 4 hours before taking charge of vessel handling operations? (Include tug/towboat captain/pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.24 If the master or mate on watch had prior duties with no break, was he working 5 to 8 hours before taking charge of vessel handling operations? (Include tug/towboat captain/pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.25 If the master or mate on watch had prior duties with no break, was he working more than 8 hours before taking charge of vessel handling operations? (Include tug/towboat captain/pilot.)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.26 Had the person in charge sailed as such 2 or more times previously with a vessel of this type (i.e., bulk carrier, container ship, oil tanker, etc.)? (Include tug/towboat-barge array.)
- NO = 0
YES = 1
NO DATA = 9
- IV.27 Had the person in charge sailed as such 2 or more times previously on this particular vessel or a sister vessel? (Include tug/towboat-barge array.)
- NO = 0
YES = 1
NO DATA = 9
- IV.28 Had the person in charge sailed as such 2 or more times previously with a vessel in this size range? (Include tug/towboat-barge array.)
- NO = 0
YES = 1
NO DATA = 9

IV.29 Had the person in charge sailed the route two or more times previously? If state licensed, answer YES.

NO = 0

YES = 1

NO DATA = 9

PART IX: NAVIGATIONAL AIDS AND TASK PERFORMANCE

If the primary vessel is a tug/towboat-barge array, answer the following questions for the tug/towboat.

IV.30 Were navigational charts and publications available on the vessel?

NO = 0

YES = 1

NO DATA = 9

IV.31 Were the charts and publications up-to-date and correct?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.32 If they were not up-to-date and correct, were the errors/omissions known to the person directing vessel handling operations?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.33 Were the charts and publications used prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.34 Was the vessel equipped with a depth-sounder?

NO = 0

YES = 1

NO DATA = 9

- IV.35 If the vessel was equipped with a depth-sounder, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.36 If the vessel was equipped with a depth-sounder, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.37 If the vessel was equipped with a depth-sounder, did the operator and the person directing vessel handling operations know how to use it?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.38 Was the vessel equipped with radar?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.39 If the vessel was equipped with radar, was at least one radar capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.40 If the vessel was equipped with radar, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.41 Was there a bearing error in the radar?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.42 If there was a bearing error in the radar, was it known to the person directing vessel handling operations and the radar operator?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.43 If the vessel was equipped with radar, did both the operator and the person directing vessel handling know how to use it?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.44 Was the vessel equipped with a collision avoidance system (CAS)?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.45 If the vessel was equipped with CAS, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.46 If the vessel was equipped with CAS, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.47 If the vessel was equipped with CAS, did both the operator and the person directing vessel handling operations know how to use it?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.48 If the vessel was equipped with CAS and standard radar, were both capable of operating properly?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.49 If the vessel was equipped with CAS and standard radar, were both on at the time of the casualty?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.50 Was the vessel equipped with an electronic navigation device (e.g., RDF, LORAN, DECCA, OMEGA).
- NO = 0
YES = 1
NO DATA = 9
- IV.51 Was there a service in the area where the casualty occurred compatible with the electronic navigation device(s) available on the vessel? (Answer NA if the vessel had no such device(s).)
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- IV.52 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one capable of operating properly?
- NO = 0
YES = 1
NA = 8
NO DATA = 9

- IV.53 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, was at least one on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.54 If the vessel was equipped with one or more electronic navigation device(s) compatible with area service, did the operator and the person directing vessel handling know how to use them?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.55 Was the vessel equipped with a wind speed and direction indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.56 If the vessel was equipped with a wind speed and direction indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.57 If the vessel was equipped with a wind speed and direction indicator, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.58 Was the vessel equipped with a wave height transducer?
- NO = 0
 - YES = 1
 - NO DATA = 9

- IV.59 If the vessel was equipped with a wave height transducer, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.60 If the vessel was equipped with a wave height transducer, was it on prior to the casualty?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.61 Was the vessel equipped with a speed indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.62 If the vessel was equipped with a speed indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.63 Was the vessel equipped with both magnetic and gyro compasses?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.64 Was the magnetic compass deviation and variation and gyro compass error known to the person in charge of vessel handling and other cognizant personnel on the bridge?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9

- IV.65 Was the vessel equipped with a rudder angle indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9
- IV.66 If the vessel was equipped with a rudder angle indicator, was it capable of operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.67 If the vessel was equipped with a rudder angle indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.68 Were there rudder angle indicator repeaters on the bridge wings? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.69 If there were repeaters on the bridge wings, were they in proper operating condition? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.70 Was the vessel equipped with an RPM indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9

- IV.71 If the vessel was equipped with an RPM indicator, was it operating properly?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.72 If the vessel was equipped with an RPM indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.73 Were there RPM indicator repeaters available on the bridge wings? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.74 If there were RPM indicator repeaters on the bridge wings, were they operating properly? (Answer NA if the vessel was a barge/barge array under tow.)
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- IV.75 Was the vessel equipped with a rate of turn indicator?
- NO = 0
 - YES = 1
 - NO DATA = 9

IV.76 If the vessel was equipped with a rate of turn indicator, was it operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.77 If the vessel was equipped with a rate of turn indicator, could the person directing vessel handling read it easily from various locations in the wheel house? (Answer YES if the vessel was a barge/barge array under tow.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

IV.80 ENTER "4" IN COLUMN 80. THIS COMPLETES CARD 4.

The following questions will be answered on Card 5.

V.1-10 Duplicate the responses given on Card 1, Columns 1 through 10.

V.11 Was the vessel equipped with a steering system status indicator and failure alarm?

NO = 0

YES = 1

NO DATA = 9

V.12 If the vessel was equipped with steering system status indicator and failure alarm, were they operating properly?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.13 Was the steering system operating at designed capability prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

- V.14 Was the vessel equipped with propulsion system status indicator and failure alarm?
NO = 0
YES = 1
NO DATA = 9
- V.15 If the vessel was equipped with propulsion system status indicator and failure alarm, were they operating properly?
NO = 0
YES = 1
NO DATA = 9
- V.16 Was the propulsion system operating at designed capability prior to the casualty?
NO = 0
YES = 1
NO DATA = 9
- V.17 Was bridge-to-bridge radio equipment onboard?
NO = 0
YES = 1
NO DATA = 9
- V.18 Was radio equipment in proper operating condition?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.19 Was radio on prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.20 Was Channel 13 being monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9

- V.21 Was Channel 16 being monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.22 Were marine weather forecasts available? Answer YES unless otherwise specified.
NO = 0
YES = 1
NO DATA = 9
- V.23 If marine weather forecasts were available, had they been monitored prior to the casualty?
NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.24 Was any other local information broadcast (e.g., VTS or other harbor advisory broadcasts).
NO = 0
YES = 1
NO DATA = 9
- V.25 If any other local information was broadcast, was this monitored prior to the casualty?
NO = 0
YES = 1
NO DATA = 9
- V.26 Was any effort made to detect hazards and aids to navigation (includes natural and other landmarks). Answer YES if docking.
NO = 0
YES = 1
NO DATA = 9

In coding columns 27-29, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

- V.27 Was visual watch only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.28 Were both electronic equipment and visual watch being used to detect hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.29 Was electronic equipment only being used as the means of detecting hazards and aids to navigation?
- NO = 0
YES = 1
NA = 8
NO DATA = 9
- V.30 Was it possible to detect hazards and aids to navigation from the bridge or pilot house by visual watch? (Answer NO if there was some aspect of vessel design or cargo loading that limited visual observation. Do not consider the atmospheric condition in answering this question. Answer NO unless specified in report.)
- NO = 0
YES = 1
NO DATA = 9
- V.31 Was there a lookout (a bow lookout on a ship or a lookout otherwise stationed on a tug/towboat-barge array)?
- NO = 0
YES = 1
NO DATA = 9

- V.32 Did the lookout make any report?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.33 If the lookout made a report, was it made in time so that avoidance action could be taken?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.34 If the lookout made a report, was it understood?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.35 Were all hazards and aids mentioned as significant in the casualty report detected? Answer NO to wind, tide, and current.
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.36 Were all hazards and aids mentioned as significant in the casualty report correctly identified in a timely manner?
- NO = 0
 - YES = 1
 - NA = 8
 - NO DATA = 9
- V.37 Was any effort made to establish navigational position prior to the casualty?
- NO = 0
 - YES = 1
 - NO DATA = 9

V.38 Was navigational position being established by visual estimation only?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.39 Was electronic equipment only being used to establish navigational position?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.40 Was navigational position being established by a combination of visual and electronic means prior to the casualty?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.41 Was navigational position correctly established?

NO = 0

YES = 1

NO DATA = 9

V.42 Was navigational position being plotted on chart prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

V.43 Was any attempt made to ascertain wind speed and direction prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 45-47, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.44 Were wind speed and direction ascertained by sensory perception only (visual and other means)?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.45 Were wind speed and direction ascertained from an indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.46 Were wind speed and direction ascertained by a combination of sensory perception and indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.47 Were wind speed and direction correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

V.48 Was any attempt made to ascertain current direction and speed prior to the casualty?

NO = 0

YES = 1

NO DATA = 9

In coding columns 50-56, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.49 Were current direction and speed ascertained from publications and/or experience?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.50 Were current speed and direction ascertained by visual (and other sensory) perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.51 Were current direction and speed ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.52 Were current speed and direction ascertained by a combination of publications/experience and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.53 Were current speed and direction ascertained by a combination of publications/experience and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

- V.54 Were current speed and direction ascertained by a combination of sensory perception and onboard or external instrumentation?
- NO = 0
 YES = 1
 NA = 8
 NO DATA = 9
- V.55 Were current direction and speed ascertained by a combination of publications/experience, sensory perception, and onboard or external instrumentation?
- NO = 0
 YES = 1
 NA = 8
 NO DATA = 9
- V.56 Were current direction and speed ascertained correctly.
- NO = 0
 YES = 1
 NO DATA = 9
- V.57 Was any attempt made to ascertain the tidal condition?
- NO = 0
 YES = 1
 NO DATA = 9
- In coding columns 59-61, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.
- V.58 Was the tidal condition ascertained from publications and/or local knowledge?
- NO = 0
 YES = 1
 NA = 8
 NO DATA = 9
- V.59 Was the tidal condition ascertained by visual estimation?
- NO = 0
 YES = 1
 NA = 8
 NO DATA = 9

V.60 Was the tidal condition ascertained from a combination of publications/
local knowledge and visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.61 Was the tidal condition correctly ascertained?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.62 Was any attempt made to ascertain wave height?

NO = 0

YES = 1

NO DATA = 9

In coding columns 64-66, NO DATA is valid only if all of the questions are
answered NO DATA. Only one may be answered YES.

V.63 Was wave height ascertained by visual estimation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.64 Was wave height ascertained from onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.65 Was wave height ascertained from a combination of visual estimation
and onboard or external instrumentation?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.66 Wave wave height properly ascertained?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.67 Was any attempt made to ascertain speed?

NO = 0

YES = 1

NO DATA = 9

In coding columns 69-71, NO DATA is valid only if all questions are answered NO DATA. Only one may be answered YES.

V.68 Was speed ascertained by a speed indicator?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.69 Was speed ascertained by sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.70 Was speed ascertained by a combination of indicator and sensory perception?

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.71 Was speed correctly ascertained?

NO = 0

YES = 1

NO DATA = 9

V.72 Was compass heading ascertained?

NO = 0

YES = 1

NO DATA = 9

V.73 Was rudder angle ascertained?

NO = 0

YES = 1

NO DATA = 9

V.74 Was RPM ascertained?

NO = 0

YES = 1

NO DATA = 9

V.75 Were rudder commands conveyed directly to the helmsman? (Answer NA if the vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

In coding columns 77-79, NO DATA is valid only if all of the questions are answered NO DATA. Only one may be answered YES.

V.76 Were propeller orders conveyed to the engine room verbally? (Answer NA if the primary vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.77 Were propeller orders conveyed to the engine room mechanically? (Answer NA if the primary vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.78 Were propeller orders effected directly through bridge control?
(Answer NA if the vessel was a tug/towboat-barge array.)

NO = 0

YES = 1

NA = 8

NO DATA = 9

V.80 ENTER "5" IN COLUMN 80. THIS COMPLETES CARD 5.

The following questions will be answered on Card 6.

PART X: ANALYSIS OF CASUALTY-PRECIPITATING FACTORS

VI.1-10 Duplicate the responses given on Card 1, Columns 1 through 10.

VI.11 Was failure to detect a hazard or aid to navigation a precipitating factor in the casualty?

NO = 0

YES = 1

VI.12 Was failure to fully identify or correctly identify a hazard or aid to navigation a precipitating factor in the casualty? (Answer NO if the hazard/aid was not identified because it was not detected.)

NO = 0

YES = 1

VI.13 Was failure to properly establish navigational position a precipitating factor in the casualty? (Answer NO if position was not established because of failure to detect or properly identify an aid to navigation.)

NO = 0

YES = 1

VI.14 Was failure to maintain proper position a precipitating factor in the casualty? (Answer NO if position was not maintained because it was not established.)

NO = 0

YES = 1

- VI.15 Was failure to evaluate a potential hazard and decide on appropriate action in time a precipitating factor in the casualty?
- NO = 0
YES = 1
- VI.16 Was failure in the execution of the navigational order(s) (where the failure was not the result of equipment failure) a precipitating factor in the casualty?
- NO = 0
YES = 1
- VI.17 Was an equipment failure such as loss of propulsion or steering, lines parted, etc., a precipitating factor in the casualty? (Exclude failures/deficiencies of navigational instrumentation.)
- NO = 0
YES = 1
- VI.18 Was a "cataclysmic" event (e.g., vessel caught in hurricane, sudden death/illness of helmsman or conning officer, explosion, etc.) a precipitating factor in the casualty?
- NO = 0
YES = 1
- VI.19 Was erratic/apparently irrational or irresponsible behavior in the conduct of vessel handling operations (e.g., an irrational order, an unqualified person left in charge of vessel handling operations, etc.) a precipitating factor in the casualty?
- NO = 0
YES = 1
- VI.20 Was a strong current phenomenon a factor in the casualty?
- NO = 0
YES = 1

- VI.21 Was a strong wind phenomenon a factor in the casualty?
NO = 0
YES = 1
- VI.22 Was the tidal condition a factor in the casualty?
NO = 0
YES = 1
- VI.23 Was a malfunctioning aid to navigation a factor in the casualty?
(Include buoys off station, light out, etc.).
NO = 0
YES = 1
- VI.24 Was ice or an ice field a factor in the casualty?
NO = 0
YES = 1
- VI.25 Was one or more other vessel(s) a factor in the casualty? (Exclude assisting vessels; exclude the struck vessel in ramming cases.)
NO = 0
YES = 1
- VI.26 Was some other floating object a factor in the casualty (other than an aid to navigation, ice, or another vessel)?
NO = 0
YES = 1
- VI.27 Was a submerged object a factor in the casualty?
NO = 0
YES = 1

- VI.28 Was a fixed structure or object in the water, other than an aid to navigation (e.g., bridge, pier, piling), a factor in the casualty?
- NO = 0
- YES = 1
- VI.29 Was shallow water (normal condition) a factor in the casualty?
- NO = 0
- YES = 1
- VI.30 Was shoaling a factor in the casualty?
- NO = 0
- YES = 1
- VI.31 Was some other physical hazard not covered by Columns 20-30 a factor in the casualty?
- NO = 0
- YES = 1
- VI.32 Was the failure to detect or identify a hazard/aid, or failure to establish position associated with failure/deficiency of navigational instrumentation?
- NO = 0
- YES = 1
- NA = 8
- NO DATA = 9
- VI.33 Was the failure to detect or identify a hazard/aid associated with its nature or condition (e.g., low profile, unlighted, submerged, etc.)?
- NO = 0
- YES = 1

- VI.34 Was an obscuring condition of the environment (e.g., rain, snow, fog, twilight, heavy sea return, shore lights, hazard hidden behind bend, etc.) a factor in the casualty?
NO = 0
YES = 1
- VI.35 Was inability to relate visual target(s) to chart a factor in the casualty?
NO = 0
YES = 1
- VI.36 Was inability to relate radar target(s) to chart a factor in the casualty?
NO = 0
YES = 1
- VI.37 If failure to establish navigational position was a factor, was it because of an error in plotting?
NO = 0
YES = 1
- VI.38 If failure to establish navigational position was a factor, was it because of delay in plotting (information not timely)?
NO = 0
YES = 1
- VI.39 Was the casualty occurrence associated with a presupposition on the part of the person directing vessel handling or other watchkeeping personnel?
NO = 0
YES = 1
NO DATA = 9

- VI.40 Was the casualty occurrence associated with a distraction onboard the vessel or within the vessel configuration (e.g., problem with towing line, something lost over the side, a fire, a fight, someone injured, etc.)?
- NO = 0
YES = 1
- VI.41 Was the casualty occurrence associated with a distraction in the operating environment (e.g., one or more moving vessels being encountered, congestion, some kind of accident or emergency not involving own vessel, construction operations nearby, etc.)?
- NO = 0
YES = 1
- VI.42 Was the casualty occurrence associated with personnel involvement in tasks not directly related to vessel control?
- NO = 0
YES = 1
- VI.43 Was the casualty occurrence associated with a communications problem related to language barrier?
- NO = 0
YES = 1
- VI.44 Was the casualty occurrence associated with a failure in communications between the primary vessel and assisting vessel(s)?
- NO = 0
YES = 1
- VI.45 Was the casualty occurrence associated with unknown error in navigational aids?
- NO = 0
YES = 1
NO DATA = 9

- VI.46 Was the casualty occurrence associated with other onboard deficiency or failure in navigational equipment?
- NO = 0
YES = 1
- VI.47 Was the casualty occurrence associated with known deficiency in navigational or other equipment?
- NO = 0
YES = 1
- VI.48 Does the report indicate that the casualty occurrence was associated with insufficient personnel training/experience?
- NO = 0
YES = 1
- VI.49 Did the casualty occur in a complex situation—i.e., a situation in which avoidance options were limited because of other nearby hazards, or by control requirements (e.g., necessity to maintain speed in strong current)?
- NO = 0
YES = 1
- VI.50 Does report indicate that speed was a factor (too fast or too slow)?
- NO = 0
YES = 1
- VI.51 Does report indicate that inadequate tug or towboat assistance was a factor?
- NO = 0
YES = 1
- VI.52 Did the total damage exceed \$1000?
- NO = 0
YES = 1
- VI.53 Did the total damage exceed \$30,000?
- NO = 0
YES = 1

VI.54 Was there loss of life or serious injury (incapacitating for over 72 hours)?

NO = 0

YES = 1

VI.80 ENTER "6" IN COLUMN 80. THIS COMPLETES CARD 6.

END 8-79